

OBITUARY NOTICES OF FELLOWS DECEASED.

The Rev. THOMAS GASKIN, who died at his residence at Cheltenham on February 17th, 1887, was born at Penrith, in Cumberland, in 1810. He was educated at Sedburgh, and for some time before he left was second in the School. On leaving Sedburgh School, in 1827, he proceeded to St. John's College. One of the men of his year writes that it was understood that he came to Cambridge under the auspices of Lord Brougham, who had formed a very high estimate of his mathematical talent, and was confident he would be Senior Wrangler. Later on, in 1851, Lord Brougham, writing a testimonial for Mr. Gaskin, speaks of an intimate acquaintance of above thirty years.

On entering St. John's College, he found the freshmen exceptionally strong in mathematics. The third wrangler of his year was then a Johnian, who afterwards migrated to Caius College. Besides the Senior, there was a fourth man reckoned equally good, whose health broke down under hard reading. Nevertheless, he was always placed first in the College examinations. This position could not be obtained, much less retained, every year, but by the exhibition of considerable classical knowledge. The late Dr. Kennedy, whose lectures he attended, entertained a favourable opinion of his promise as a classical scholar, though his chief attention was then devoted to mathematics. It has also been stated on the authority of some of his old schoolfellows, that on leaving Sedburgh he could repeat above twenty Greek plays by heart.

He took his degree of B.A. in 1831, as second wrangler and second Smith's prizeman, a member of his own College being Senior. The two were so nearly equal in merit that there was great difficulty in arranging their order. According to the custom of that day, cases of near equality were decided by questions given out orally, one by one, by some competent Master of Arts, not one of the Moderators or Examiners. In such a system a previous accidental acquaintance with the subject matter of a question would make an appreciable difference. Thus their positions in the final list, if decided by an insufficient number of questions, might indicate a greater difference than really existed.

Soon after his degree he was elected Fellow and Tutor of Jesus College, the duties of which responsible position he continued to discharge for eleven years. When, on his marriage, in 1842, he resigned these offices, a subscription was opened among his friends

and pupils, and he was presented with a valuable service of plate, as a testimony of their respect and esteem.

During his twenty years' residence in the University, he was almost uninterruptedly engaged in preparing pupils for the examination, and in writing books on subjects connected with their studies. He also during this time served the University in the difficult and responsible office of Proctor. He was six times chosen Moderator, viz., in the years 1835, 1839, 1840, 1842, 1848, and 1851. This is an appointment which no one before him had ever held so often. These repeated re-elections prove the general esteem in which his extraordinary power in constructing problems was held.

In 1836, Mr. Gaskin was elected a Fellow of the Royal Astronomical Society, and in 1839 he became a Fellow of the Royal Society.

He removed to Cheltenham about 1855, where he spent the remainder of his life. During his residence at this place, he occupied himself almost entirely with private pupils until his health failed. He here published a pamphlet on the theory and practice of *solitaire*. Subsequently, the broken state of his health, the early deaths of his sons and of his wife, made him choose a retired life, and prevented him from devoting his time to work. He seems never to have been a strong man, for he was an invalid even when Tutor of Jesus College.

Mr. Gaskin, when resident in Cambridge, was especially known for his unrivalled skill in the construction and solution of problems, especially such as required the application of complicated analysis. Indeed, we can see by his writings that this was the bent of his talents. In 1847, he published two volumes of "*Solutions of Trigonometrical and Geometrical Problems.*" These were the solutions of examination papers set in St. John's College for the years 1830 to 1846. Though these books are of an elementary character, yet they must have had considerable influence on the studies of those seeking distinction in the examinations of that day. Even after this lapse of time, when so many new methods have come into use, a teacher would find here a useful collection of problems and examples with admirable solutions, a store-house from which he might draw material to lighten his own labours.

In the appendices, he added the solution of some other geometrical problems which were exciting interest at the time.

He also wrote in the '*Mechanic's Magazine*,' and in 1848 published some papers on the inscription of polygons in the conic sections.

In Dr. Hymer's treatise on "*Differential Equations*," we find the solution of one of the problems proposed by him in the Senate House, when Moderator in 1839, given as the best and simplest

method of solving an important differential equation. This is the equation, a particular case of which occurs in the theory of the figure of the earth.

The problems and examples set in the Senate House are generally absorbed into the ordinary text-books, and become the standard examples by which successive generations of students acquire their analytical skill. On looking through Mr. Gaskin's papers, one cannot help noticing how many of his problems have been taken, and may be recognised as old friends. We thus learn one reason at least why his papers were so popular amongst the older writers. They are on all kinds of subjects, and generally are put in a way which shows that he was always on the look-out for a telling question. It seems to have been his custom to put any new theorem that he discovered in the form of a problem, rather than in that of a paper in a mathematical journal.

E. J. R.

DR. ARTHUR FARRE, the fifth son of the late Dr. John Richard Farre, was born in 1811, in the house in Charterhouse Square in which his father lived and practised for many years. He received his early education at the Charterhouse. In 1827 he became a pupil at St. Bartholomew's Hospital, and the following year he entered at Caius College, Cambridge. In the intervals of the University terms he prosecuted his medical studies at St. Bartholomew's. He was a diligent dissector, and as prosector under Abernethy, he prepared subjects for the last course of lectures on physiology delivered by that eminent surgeon. He graduated M.B. at Cambridge at the head of the medical list in 1833, and M.D. in 1841.

During 1836-7 Dr. Farre lectured on Comparative Anatomy at St. Bartholomew's Hospital, in succession to Mr. (now) Sir Richard Owen. From 1838 to 1840 he lectured on Forensic Medicine.

Dr. Farre contributed to the 'Philosophical Transactions' for 1837 an elaborate paper with numerous lithographic illustrations, entitled "Observations on the Minute Structure of the Higher Forms of Polypi, with views of a more natural Arrangement of the Class." The publication of this paper was followed by his election as a Fellow of the Royal Society in 1839. To the 'Philosophical Transactions' for 1843 Dr. Farre contributed a paper "On the Organ of Hearing in the Crustacea."

Dr. Farre's professional career was determined for him when, in the year 1842, he succeeded Dr. Robert Ferguson in the chair of Obstetric Medicine at King's College, and at the same time he was appointed Physician Accoucheur to King's College Hospital. These appointments he retained until 1862, when, on his retirement, he was made Consulting Physician.

He became a member of the College of Physicians in 1838, and was elected a Fellow in 1843. He was Censor in 1861-2, and Senior Censor in 1865. In 1872 he delivered the Harveian Oration, taking as his subject "Harvey's Exercises on Generation."

For a period of twenty-four years he held the appointment of Examiner in Midwifery at the Royal College of Surgeons.

Dr. Farre possessed all the qualities required in a great and successful obstetric physician, and he soon acquired a large practice amongst the very highest ranks. He attended the Princess of Wales at the birth of all her children. He also attended the late Princess Louis of Hesse Darmstadt, Princess Alice of Great Britain, in her first confinement; also Her Imperial Highness the Duchess of Edinburgh, in her first confinement at Buckingham Palace, in 1874, and again at Eastwell Park, in 1875. He attended Princess Christian in 1867, at Windsor Castle, and again in 1869, at Cumberland Lodge. He attended the Princess Mary Adelaide in all her confinements, and the Princess Leiningen in 1863, at Osborne. Few physicians have had the honour to attend successfully so many members of the Royal Family.

In 1875 Dr. Farre received the appointment of Physician Extraordinary to Her Majesty, and although no word of dissatisfaction ever escaped from him, his friends and professional brethren thought it strange that this should have been the only public royal recognition of his eminent services.

After the death of Sir Charles Locock, in 1875, Dr. Farre was made Honorary President of the Obstetrical Society.

His chief literary contribution to his own department of medicine was the elaborate article "Uterus and its Appendages," in Todd's 'Cyclopædia of Anatomy and Physiology.' Dr. Robert Barnes says of this article that it "is the fruit of remarkable labour and original research, digested and set forth with consummate judgment. To this day it stands, if not unrivalled, yet unsurpassed. It is rich in original illustrations, and just in acknowledging what is borrowed. It may be doubted whether any similar work has stood the trying test of time so well. Others may have added to it; few have made corrections that have held their ground."*

Dr. Farre was one of the founders of the Microscopical Society; he was its first honorary secretary, and served several times on its council, and in 1851-52 he was its President. Through the influence of the Prince of Wales he obtained for the Society its Royal Charter.

He communicated several papers to the Microscopical Society, amongst others the following:—"On the Minute Structure of certain Substances expelled from the Human Intestine, having the ordinary appearance of shreds of lymph, but consisting entirely of filaments

* 'Brit. Med. Journal,' Dec. 24, 1887.

of confervoid type, probably belonging to the genus *Oscillatoria*" ('Mic. Soc. Trans.,' 1, 1844); "An Account of the Dissection of a Human Embryo of about the fourth week of Gestation, with some observations on the early development of the Human Heart" ('Mic. Soc. Trans.,' 3, 1852); "Description of an early human Embryo of about the fourth week of Utero-Gestation" ('Mic. Soc. Trans.,' 5, 1857).

In the 'Medical Gazette' for 1835 (vol. 17), Dr. Farre published a paper on the 'Trichina Spiralis.' In the previous volume of the Gazette the discovery of the parasite is referred to as follows:—"The muscles of bodies dissected at St. Bartholomew's Hospital had been more than once noticed by Mr. Wormald, the demonstrator, to be beset with minute whitish specks, and their appearance having been again remarked in the body of an Italian aged 45, by Mr. Paget, a student of the hospital (now Sir James Paget), who suspected it to be produced by minute entozoa, the suspicion was found to be correct, and Mr. Owen was furnished with portions of the muscles on which he had made the following observations." An account is then given of the observations of Professor Owen, who named the parasite *Trichina spiralis*. A second body infested by this parasite had been observed in the dissecting room of St. Bartholomew's, within a fortnight after the occurrence of the first, and the object of Dr. Farre's paper was, as he said, mainly to refer to some points on which he was able to give some additional information, or as to which his observations differed from those of Professor Owen. In particular he had been able to make out in some specimens the existence of a distinct alimentary canal and an ovary. A paper by Dr. Farre "On *Diplosoma crenata*, an entozoon inhabiting the human bladder, and hitherto often confounded with *Spiroptera hominis*," was published in Beale's 'Archives of Medicine,' vol. 1, p. 290).

The article "Worms," in the 'Library of Medicine' (vol. 5, p. 241), was contributed by Dr. Farre.

At a time when Dr. Farre was overworked and harassed by his large practice, he had the great sorrow of losing his wife, and shortly afterwards he sustained a compound dislocation of the ankle, in consequence of a fall from a second floor window into the area of his house. The wound gradually healed, and he was able to move about, first with crutches, and then with the help of a stick; but he remained painfully lame until his death, which occurred on the 17th December, 1887.

Dr. Farre's lectures and his clinical teaching were highly appreciated by his pupils, of whom the writer of this notice had the good fortune to be one. He was a model physician accoucheur, and he acquired the confidence and esteem of the profession through his diagnostic and practical skill, and the high principles and sense of

honour by which he was guided in all the relations of life. A most charming and genial companion, an affectionate and constant friend, he delighted those who enjoyed the privilege of his society and his generous hospitality by his musical accomplishments, which were of a very high order.

G. J.

GUSTAV ROBERT KIRCHHOFF was born on March 12, 1824, at Königsberg. He began his studies in his native town under the direction of F. E. Neumann, and no one who has studied the writings of both these eminent men can fail to notice the great influence which Neumann's teaching must have had in forming the character of Kirchhoff's scientific ideas.

In 1850 Kirchhoff went as Professor Extraordinarius to Breslau, and in 1854 as Professor of Physics to Heidelberg, where he stayed till 1875. In that year he accepted a chair of Physics in Berlin. Gradually failing in health he had to give up his lectures, and died on October 17, 1887.

His writings, the first of which he published at the age of twenty-one, cover nearly the whole range of physics, and there is hardly one of them which has not marked a decided progress in the subject to which it refers.

His first paper (1845), treating of plane current sheets, was the first of a series in which he deduced and applied the now well-known equations for the distribution of electric currents in conductors which are not linear. In 1849 an important communication appeared in Poggendorff's 'Annalen,' in which, for the first time, the resistance of a wire was measured in what is now known as electromagnetic measure. A paper of considerable interest, "Ueber die Bewegung der Elektrizität in Leitern," appeared in the year 1857. The propagation of electric effects in wires is discussed in this paper, the principal result being: "that the rate of propagation of electric waves is found to be $c/\sqrt{2}$ —that is, independent of the cross section, the coefficient of conductivity of the wire, and the electric density; the rate is 41,950 (German) miles per second, or very nearly the same as that of the propagation of light." In view of the important conclusions to which modern researches in electricity have led, considerable historical interest will always attach to the above statement. The remaining electrical papers treat of the oscillating discharge of the Leyden jar, the distribution of electricity on two conducting spheres, and of the capacity of a condenser formed of two parallel circular plates.

We have next two papers on Magnetism; one (1853) treats of the magnetism induced in an infinitely long cylinder, and the other solves the problem of the magnetisation of an iron ring under the influence

of electric currents. A suggestion made in the latter paper to use closed rings of iron for the determination of the coefficient of induction has led, at the hands of Stoletow and Rowland, to important practical results.

Kirchhoff's name is most generally known in connexion with his researches on the relation between the absorptive and the emissive properties of bodies. The explanation of the Fraunhofer lines which are derived from these researches, and the work done jointly with Bunsen on the discontinuous spectra of gaseous bodies, gave such an impulse to the study of radiation that a whole science—that of spectrum analysis—developed as a historical sequence to Kirchhoff's work. It is a curious instance of an abstruse calculation giving rise to extended experimental investigations which have in reality very little connexion with it; for it is only a small fraction of spectrum analysis in which the connexion between radiation and absorption is made use of at all. There is really no *a priori* reason why we could not have known as much as we do now of the spectra of different bodies without being acquainted with the important law proved by Kirchhoff.

A discussion has arisen as to how far Kirchhoff's work was anticipated by that of Balfour Stewart. The latter had experimented on the radiation and absorption of heat, and had drawn some important conclusions from his experiments. Stewart's work is conclusive in showing that if we assume the ratio of the emissive to the absorptive power to be the same for all bodies and only a function of the temperature and wave-length, all facts can be satisfactorily accounted for. Kirchhoff, without being acquainted with Stewart's researches, went further, and proved that the law just stated is the only one consistent with thermodynamical equilibrium. Kirchhoff's paper has been objected to as being too elaborate in the method of its proof, but no simpler proof has ever been given, and it would be difficult to lay a finger on a single sentence of this classical paper which could be removed or shortened without detriment to the logical sequence of the argument.

In connexion with these theoretical researches and in order to trace the existence of terrestrial elements in the sun, Kirchhoff prepared a drawing of the solar spectrum. Unfortunately an arbitrary scale was used, and the prisms were occasionally shifted, so that the map was soon superseded by Ångström's, in which the lines were directly referred to wave-lengths. It seems of interest, however, to point out as a proof of the acuteness of Kirchhoff's observing power and the perfection of the optical adjustments, that the amount of detail given in his map is exactly that given by calculation as possible with the resolving power which he used. No work could be more trying than that of drawing a map of the solar spectrum reaching the

limits of the instrumental powers; Kirchhoff's eyes suffered in consequence, and he had to leave the completion of the map to K. Hofmann.

Soon after the mathematical development by Clausius and Sir William Thomson of the mechanical theory of heat, Kirchhoff was the first to carry the application of that fruitful theory into the domain of Chemical Physics. The thermal phenomena connected with the absorption of gases and the dissolution of salts in liquids as well as their relationship with the vapour-pressures of the solvent, were treated in two papers of great interest and importance.

A few words must be said on Kirchhoff's papers on elasticity.

There are few problems which have occupied so many eminent mathematicians, and our author's investigations contributed very materially to the progress of that important branch of theoretical physics. Before Kirchhoff's time Sophia Germain had made an attempt which was only partially successful to establish the equations which regulate the vibrations of thin plates. Poisson had gone a good deal further, especially as regards the treatment of rectangular plates. Kirchhoff points out that Poisson's boundary conditions cannot in general be satisfied, and deduces from the general theory of elasticity a solution which can be applied to circular plates. With the help of measurements made by M. Strehlke, the theoretical results were checked and verified by experiment. In some later papers the elastic deformations of rods were treated in a more general way than had previously been done, and especially in 1879 the solution of the problem was extended to prismatic and conical rods.

The science of hydrodynamics also is indebted to Kirchhoff for several beautiful investigations, amongst which special attention may be drawn to the paper "*Zur Theorie freier Flüssigkeitsstrahlen*," and to one in which it is shown that two rigid rings in a fluid moving irrotationally exert apparent forces on each other which are identical with those which the rings would show if electric currents were to circulate round them.

Kirchhoff's papers have been collected into a volume of moderate size. He has also published a series of lectures on mechanics, in which we are especially struck with the precision with which the subject is treated, and with the way all metaphysical difficulties in the first definitions are avoided. "For this reason," he says in the introduction, "I take it to be the object of mechanics to *describe* the phenomena of nature, to describe them completely and in the simplest manner. I mean that it will be our task to state what the phenomena are, but not to find out the *causes*." None of those who have attended Kirchhoff's lectures on mathematical physics are ever likely to forget them. Each lecture was complete in itself, and the student felt on leaving the room that he had learnt

something which it would be difficult or impossible for him to find in the published books. He was in consequence a popular and successful teacher, and nearly all the younger German physicists are his pupils.

In Kirchhoff science has lost a man who combined, to an exceptional degree, mathematical talent with observational skill and experimental knowledge.

A. S.

Dr. BALFOUR STEWART was born in Edinburgh on November 1st, 1828, and died in Ireland on December 18th, 1887, having just entered his sixtieth year. He was educated for a mercantile profession, and in fact spent some time in Leith, and afterwards in Australia, as a man of business. But the bent of his mind towards physical science was so strong that he resumed his studies in Edinburgh University, and soon became assistant to Professor J. D. Forbes, of whose class he had been a distinguished member. This association with one of the ablest experimenters of the day seems to have had much influence on his career; for Forbes's researches (other than his Glacier work) were mainly in the department of Heat, Meteorology, and Terrestrial Magnetism, and it was to these subjects that Stewart devoted the greater part of his life. In the classes of Professor Kelland, Stewart had a brilliant career; and gave evidence that he might have become a mathematician, had he not confined himself almost exclusively to experimental science.

In 1858, while he was still with Forbes, Stewart completed the first set of his investigations on Radiant Heat, and arrived at a remarkable extension of Prévost's "Law of Exchanges." His paper (which was published in the 'Transactions of the Royal Society of Edinburgh') contained the greatest step which had been taken in the subject since the early days of Melloni and Forbes. The fact that radiation is not a mere surface phenomenon, but takes place like absorption throughout the interior of bodies, was seen to be an immediate consequence of the new mode in which Stewart viewed the subject. Stewart's reasoning is, throughout, of an extremely simple character, and is based entirely upon the assumption (taken as an experimentally ascertained fact) that in an enclosure, impervious to heat and containing no source of heat, not only will the contents acquire the same temperature, but the radiation at all points and in all directions will ultimately become the same, in character and in intensity alike. It follows that the radiation is, throughout, that of a black body at the temperature of the enclosure. From this, by the simplest reasoning, it follows that the radiating and absorbing powers of any substance must be exactly proportional to one another (equal, in fact, if measured in proper units), not merely for the radiation as

a whole, but for every definitely specified constituent of it. In Stewart's paper (as in those of the majority of young authors) there was a great deal of redundant matter, intended to show that his new views were compatible with all that had been previously known, and in consequence his work has been somewhat lightly spoken of, even by some competent judges. These allow that he succeeded in showing that equality of radiation and absorption is consistent with all that was known; but they refuse to acknowledge that he had proved it to be necessarily true. To such we would recommend a perusal of Stewart's article in the 'Philosophical Magazine' (vol. 25, 1863, p. 354), where they will find his own views about the meaning of his own paper. The only well-founded objection which has been raised to Stewart's proof applies equally to all proofs which have since been given, viz., in none of them is provision made for the peculiar phenomena of fluorescence and phosphorescence.

The subject of radiation, and connected properties of the luminiferous medium, occupied Stewart's mind at intervals to the very end of his life, and led to a number of observations and experiments, most of which have been laid before the Royal Society. Such are the "Observations with a Rigid Spectroscope," and those on the "Heating of a Disk by rapid Rotation *in vacuo*," in which the present writer took part. Other allied speculations are on the connexion between "Solar Spots and Planetary Configurations," and on "Thermal Equilibrium in an Enclosure containing Matter in Visible Motion."

From 1859 to 1870 Stewart occupied, with distinguished success, the post of Director of the Kew Observatory. Thence he was transferred to Manchester as Professor of Physics in the Owens College, in which capacity he remained till his death. His main subject for many years was Terrestrial Magnetism; and on it he wrote an excellent article for the recent edition of the 'Encyclopædia Britannica.' A very complete summary of his work on this subject has been given by Schuster in the 'Manchester Memoirs' (4th series, vol. 1, 1888). In the same article will be found a complete list of Stewart's papers.

Among the separate works published by Stewart, his 'Treatise on Heat,' which has already reached its fifth edition, must be specially mentioned. It is an excellent introduction to the subject, though written much more from the experimental than from the theoretical point of view. In the discussion of radiation, however, which is given at considerable length, a great deal of theoretical matter of a highly original character is introduced.

Of another work, in which Stewart took a great part, 'The Unseen Universe,' the writer cannot speak at length. It has

passed through many editions, and has experienced every variety of reception—from hearty welcome and approval in some quarters to the extremes of fierce denunciation, or of lofty scorn, in others. Whatever its merits or demerits it has undoubtedly been successful in one of its main objects, viz., in showing how baseless is the common statement that “Science is incompatible with Religion.” It calls attention to the simple fact, ignored by too many professed instructors of the public, that human science has its limits; and that there are realities with which it is altogether incompetent to deal.

Personally, Stewart was one of the most loveable of men, modest and unassuming, but full of the most weird and grotesque ideas. His conversation could not fail to set one a-thinking, and in that respect he was singularly like Clerk-Maxwell. In 1870 he met with a frightful railway accident, from the effects of which he never fully recovered. He passed in a few months from the vigorous activity of the prime of life to grey-headed old age. But his characteristic patience was unruffled and his intellect unimpaired.

He became a Fellow of the Royal Society in 1862, and in 1868 he received the Rumford Medal.

His life was an active and highly useful one; and his work, whether it took the form of original investigation, of accurate and laborious observation, or of practical teaching, was always heartily and conscientiously carried out. When a statement such as this can be truthfully made, it needs no amplification.

P. G. T.

Dr. OWEN REES was born at Smyrna in November, 1813. His father was a Levantine merchant, and married an Italian lady, by whom he had a large family. Owing to his father's failure in business, he was obliged to be educated at a private school, and for the same reason many of his family in after years were compelled to reside with him. This is probably the explanation of his remaining unmarried. He, however, found a good patron in his uncle, who was a partner in the publishing firm of Longman and Co. In 1829 Owen Rees was apprenticed to Mr. Richard Stocker, the apothecary at Guy's Hospital, and he very soon showed his inclination towards scientific pursuits, and especially to chemistry. He attracted the attention of Dr. Bright, who requested his assistance in the analysis of the secretions in diseases of the kidney, and in this way a lifelong friendship sprang up between them. He made quantitative analyses of the albumen and urea in the urine, and proved the presence of the latter in the blood. His papers on this subject are to be found in the ‘Medical Gazette’ for the year 1833.

In the year 1837 he took his degree at Glasgow, and shortly afterwards published a small work entitled ‘Analysis of the Blood and

Urine in Health and Disease.' In his preface the author says "the increased desire for more intimate acquaintance with animal chemistry, which has lately been evinced by the medical profession, induces me to present this little work to public notice. The more philosophical modes of investigation at present adopted to ascertain the diseased conditions of the living system, have found a new branch of inquiry deserving the attention of the student." He then describes his method of separating the various ingredients of the blood, and as regards his discovery of urea he evaporated the blood to dryness and treated the residue with ether. He also made an exhaustive analysis of the urine, showing that the colouring-matter was a distinct principle, and gave the various tests for albumen. Bright had already observed that the phosphates were precipitated by heat, and thus was sometimes a cause of error in testing for albumen. He referred to Rees for an explanation, who, after a series of experiments, determined that it was muriate of ammonia which kept the phosphates in solution, and that it was the decomposition of this which thus necessarily caused their precipitation. For the presence of sugar he did not use chemical tests, but evaporated the urine and dissolved out by alcohol. In a paper published in 1838 in the 'Guy's Hospital Reports,' Rees showed how sugar could be obtained from diabetic blood, as its presence therein had been previously doubted. He evaporated the blood, soaked the residue in water, treated with ether to remove urea and fat, and then allowed the remainder to crystallise.

In the year 1841 Rees made, in conjunction with Mr. Samuel Lane, some very important observations on the corpuscle of the blood. They concluded that it was a flattened capsule containing a coloured fluid, and they further showed the changes which it underwent on the application of reagents as saline fluids and syrup. They inferred from this that in the living body there must be a similar osmotic change going on, as in anæmia and in cases where the saline substances were in excess. Rees subsequently made observations on the nucleus of the corpuscle in different animals, and showed the similarity of the white corpuscle to that of lymph and pus. Although finding urea in various secretions in cases of diseases of the kidney, yet often failing to discover it in the blood, he doubted whether its presence was the cause of convulsions and other nervous symptoms so frequently met with in *Morbus Brightii*.

He communicated two papers to the Royal Society—one in 1842 entitled "On the Chemical Analysis of the Contents of the Thoracic Duct in the Human Subject." The fluid was obtained from a criminal executed at Newgate, and taken an hour after death. An article on chyle and milk, written afterwards, is to be found in Todd and Bowman's 'Cyclopædia of Anatomy and Physiology.' His other paper presented to the Royal Society was entitled "On the Formation

of the Red Corpuscles of the Blood and on the Process of Arterialisation." His theory was that the venous blood contained phosphorus in combination with fat, and that an oxidation took place, and the phosphoric acid united with the alkali of the blood, producing a tribasic phosphate of soda. This caused the bright colour of arterial blood.

Rees also wrote a little book on calculous diseases. This consisted mainly of the Croonian Lectures given at the College of Physicians in the year 1856. In the 'Guy's Hospital Reports' various papers will be found on chemical analysis of animal fluids. Owen Rees, in many instances, joined Dr. Alfred Taylor in his criminal investigations, notably in the case of Palmer, who was tried for the murder of Cook by strychnia in the year 1856. He also assisted Sir B. Brodie in his analysis of urinary calculi, and it was owing to this surgeon's influence that Dr. Rees gained the appointment of Physician to the new Pentonville Prison.

Dr. Owen Rees was appointed Assistant-Physician at Guy's Hospital in the year 1843, and full Physician in 1856. In 1873 he resigned, and was appointed Consulting Physician. He was a particular friend of Dr. Roget, who presented the papers spoken of to the Royal Society, of which Dr. Roget was then Secretary. It was soon afterwards, in the year 1843, that he was made a Fellow.

Dr. Rees was in practice first in Cork Street and afterwards in Albemarle Street. His clients were amongst the better classes, and usually sufferers from kidney disease or gout, for the treatment of which disorders he had gained considerable repute. Personally, he was a small, lithe, active man, ready and sociable, so that he was a well-known member at the Athenæum and many convivial clubs. He was very quaint and humorous in his stories, so that his company was much sought after. He was, in his latter days, made Physician Extraordinary to the Queen. In the beginning of 1886 he was seized with a paralytic stroke, but although he partly recovered he never did much work afterwards. On May 27th, 1889, he had another seizure, which proved fatal, and he was buried in Abney Park Cemetery, aged 76 years. S. W.

Sir CHARLES JAMES FOX BUNBURY, Bart., was born at Messina, in Sicily, February 4th, 1809, where his father, General Sir Henry Bunbury, was at that time Quartermaster-General. His mother was a daughter of General Fox, then commanding in the Mediterranean, and a niece of the celebrated statesman. To these gifted parents Sir Charles owed his early love and his knowledge of arts, literature, and science, and especially of natural history, accomplishments which he cultivated throughout life with disinterested zeal; and thanks to his extraordinary memory, his accuracy was as remarkable as were the extent and variety of his information.

After completing his education at Trinity College, Cambridge, Mr. Bunbury visited Brazil and the River Plate, whither he was attracted by the fact of his uncle, Mr. Fox, himself an ardent collector of plants, being Minister at Monte Video. This was followed by a voyage to South Africa, where another uncle, General Sir George Napier, was Governor of the Cape Colony; and in 1853 he accompanied Sir Charles Lyell to Madeira and Teneriffe. In all these countries Sir Charles Bunbury made extended excursions, observing diligently and collecting assiduously, though travelling as an amateur rather than a scientific naturalist. The results of these journeys are full of interest to the botanist, zoologist, and geologist; they are published in various scientific periodicals, and in a 'Visit to the Cape,' which appeared in 1847. Especially valuable are the botanical observations made in South Africa and South America, which deal with the broad features of a vegetation known previously only in detail. They are brought together in a volume published shortly before his death, entitled 'Botanical Fragments.'

It is, however, by his researches in vegetable palæontology that Sir Charles Bunbury is best known as a scientific man. To this subject his attention was more immediately drawn through his connexion by marriage with Sir Charles Lyell, and his most valuable contributions to it may be said to be ancillary to Sir Charles's investigations into the coal-measures of British North America and the United States; they appeared in the form of a succession of communications to the Geological Society of London between 1846 and 1861, and are printed in that Society's Journal. He also wrote on the Carboniferous flora of the Tarentaise, on the Anthracites of Savoy, on the Jurassic flora of Yorkshire, on the Fossil plants of Nagpur in the Deccan Peninsula, and of the Island of Madeira. Under this head, too, should be recorded the great services he rendered to palæontology, by classifying and naming the Carboniferous fossils in the Museum of the Geological Society (of which Society he was Foreign Secretary from 1847 to 1853). This collection was for many years the only one of its kind in England available to geologists or botanists.

In 1844 Mr. Bunbury married Frances Joanna, daughter of Leonard Horner, Esq., F.R.S., and sister to Lady Lyell, who survived him. In 1860 he succeeded, through the death of his father, to the baronetage, and removed from the Manor House of Mildenhall, to the family seat, Barton Hall, Bury St. Edmunds, where he died June 18th, 1886, leaving no descendants. He was a Fellow of the Linnean and Geological Societies, as well as of the Royal Society, into which he was elected in 1851.

J. D. H.

ASA GRAY was born November 8, 1810, in the township of Paris, Oneida Co., New York. He was descended on the father's side from a Scotch-Irish family that had emigrated early in the 18th century. His mother was a lady of English descent. As a boy he assisted in his father's farming, and, showing an aptitude for and love of book-work, he was sent, first to a private school, thence to the Grammar School of Clinton, N.Y., and lastly to the Fairfield Academy. To this latter institution a medical school of repute was attached, and it was through attendance on its lectures that Gray became interested in scientific pursuits, and especially in botany, through an article in 'The Edinburgh Encyclopædia.' In 1825 he entered the Fairfield Medical School, the sessions of which occupying only half the year, left him ample time for following his favourite pursuits of botany and mineralogy in the study and in the fields. In 1831, having taken his doctor's degree at Fairfield, he forthwith abandoned the thoughts of medicine as a profession, and accepted the post of Instructor in Chemistry, Mineralogy, and Botany in the High School of Utica, N.Y. After spending several years in botanising and in lecturing in various educational establishments, he became Assistant to Professor Torrey in the Chemical Laboratory of the Medical School at New York. This, though it led to nothing professionally, was perhaps the turning point in Gray's career, for Torrey was an able and ardent botanist, who had already recognised Gray's ability, and a life-long friendship was established between them, to be emphasised by the joint publication of 'The Flora of the North American Continent,' a work justly esteemed as second alone to De Candolle's 'Prodromus Regni Vegetabilis' as a contribution to a knowledge of the vegetation of the globe.

In 1835 Gray became Curator and Librarian of the New York Lyceum of Natural History, a post which gave him abundant leisure; and this he employed in the preparation of his 'Elements of Botany,' which was at once accepted as the best text-book of the science that had appeared in the States, and as second to none in the English language. The 'Elements' is the first of a series of educational works on morphological, physiological, and systematic botany that have been for half a century the class-books of schools and colleges throughout the United States and in British America, and which have been cordially recommended by teachers in England as the best of their class. Nor should mention be omitted of two smaller educational works, entitled 'How Plants Grow,' and 'How Plants Behave,' which, "for the interest of their subject, the elegance of their diction, and the lucidity of their style, have led the general public to appreciate the scientific aspect of botany more perhaps than have any other in the English language."*

* Of these *libelli* a competent American author has written that "they found

In 1836 Dr. Gray was appointed Botanist to Commodore Wilkes's voyage of exploration in the Pacific and Antarctic regions ; but after experiencing innumerable delays, and uncertainties as to the management of the expedition, and as to his own position in it, he withdrew from the enterprise. It is idle to speculate on the loss to science thus incurred. It may reasonably be assumed, however, that if science lost much in the form of invaluable observations, original researches, and copious collections, America gained much by the retention of Gray's personal influence, his teaching, and the elaboration of its flora.

Settling in New York, Gray now devoted his whole energies in conjunction with Torrey to 'The Flora of North America,' of which the first parts appeared in 1838, and the last that have been published very shortly before his decease. Torrey was the projector of the work, but even from the first the lion's share fell to Gray, who is practically its sole author. To put briefly the amount of labour involved in Gray's systematic and descriptive publications on the North American Flora, it may be stated that they may embrace in one form or another a great proportion of the 10,000 or 11,000 species that the continent possesses. Of these more than half are so carefully and methodically described in the volumes of the Flora that have appeared, that there is perhaps no instance of a species being misplaced as to genus, and in few could a better grouping of species into subordinate divisions be suggested. The remainder are described in more or less detail in innumerable papers, in answer to demands for immediate publication in the 'Reports of Government Expeditions,' or in the works of travellers and collectors. These scattered publications would, as it was hoped by the author, have accelerated the pace of the great work ; but the contrary was the result, and the prospects of the completion of the Flora are far distant, if existent.

Of Gray's numerous other works four are especially noteworthy : his 'Manual of the Botany of the Northern United States,' of which it is justly written by an eminent American author, that the botanist has yet to be born who could give a more clear, accurate, and compact account of the flora of a country ; the 'Genera Floræ Americæ Borealis Orientalis illustrata,' a work designed to illustrate and describe the morphology, affinities, and distribution of plants in the area indicated, but discontinued after the first two volumes ; the 'Botany of Commodore Wilkes's South Pacific Exploring Expedition,' of which a quarto volume, with a superb atlas of plates, was published, when the withdrawal of funds arrested its further progress ; lastly, an essay on the flora of Japan, which, in point of

their way where botany as botany could not have gained an entrance, and they set in motion a current which moved in the general direction of a higher science with a force that can hardly be estimated."

originality and far-reaching results, is the author's *opus magnum*. In it, by a comparison of the floras of Eastern and Western America with one another and with Japan, and of all with the Tertiary flora of North America, Gray has outlined the history of the vegetation of the north temperate zone in relation to its past and present geographical features, from the Cretaceous period to the present time. The above are works of research, but there remain two labours of this most industrious botanist which demand a notice; these are the part he took in the controversy that followed the publication of Darwin's 'Origin of Species,' and his extraordinary activity as a reviewer, bibliographer, and historian of the progress of botany during his life-time.

Gray was one of the first to accept and defend the doctrine of natural selection, which he further fortified by masterly reasoning, judicious criticism, and by experiments; so that Darwin, whilst fully recognising the different standpoints from which he and Gray took their departures, and their divergence of opinion on important points, nevertheless regarded him as the naturalist who had most thoroughly gauged the 'Origin of Species,' and as a tower of strength to himself and his cause. It is not needful to dwell further on this subject; Gray's intimacy with Darwin, and their most interesting and instructive correspondence, are matters of history, and together with their divergent sentiments, are fully set forth in the life of the latter, and in two works by Gray entitled 'Darwiniana' and 'Science and Religion.'

It remains to allude to Gray's labours as a reviewer and bibliographer. Amongst his many accomplishments, not the least was his intimate knowledge of the early and latter history of botany, and of the writings and doings of botanists everywhere. For fifty years (the last thirty as co-editor of 'Silliman's Journal') he kept the American scientific public fully informed of the progress of his favourite science in Europe and elsewhere, of all publications of value, of the movements of botanical travellers, and of the changes in the staff of museums, gardens, herbaria, &c. An American* colleague says of him, "As a reviewer he was certainly extraordinary. Some of his reviews were, in reality, elaborate essays, in which, taking the work of another as a text, he presented his own views on important points in a masterly manner. Others were technically critical, while some were concise and clear summaries of lengthy works. Taken collectively, they show better than any other of his writings the literary excellence of his style, as well as his great fertility and acuteness as a critic. Never unfair, never ill natured, his sharp criticism, like the surgeon's knife, aimed not to wound, but to cure; and if he sometimes felt it his duty to be severe, he never failed to praise what was

* Professor Farlow, "Memorial of Asa Gray," in the 'Proceedings of the American Academy of Arts and Sciences,' p. 33.

worthy. His style was so easy, so flowing, and so constantly enlivened by sprightly allusions and pleasing metaphors, that one can read what he wrote for the mere pleasure of reading it. He was one of the rare cases where science had appropriated to herself one who who would have been an ornament to any purely literary profession."

In 1842 Gray was appointed to fill the newly-endowed chair (the Fisher) of Natural History in Harvard College, to which was attached the direction of the Botanical Gardens at Cambridge, Mass. From this time he devoted his chief energies to creating a botanical library and herbarium, and to the continuation of the Flora of North America. For upwards of thirty years he fulfilled the duties of Lecturer and of Director of the Gardens, during which he raised the whole botanical establishment, garden, library, and herbarium, to first-rate importance. In 1872 he was relieved of the duties of lecturing, and shortly after of the charge of the garden, and had an assistant appointed to the herbarium; but he retained the title of Fisher Professor and Director of the Gardens until his death.

Having made six visits to Europe, entailing several lengthy stays in England, in furtherance of the Flora, his wiry figure, his vivacity, and the alertness of his intellect were well known in this country, where his highly cultivated mind and the charm of his personality won him friends in all circles of society. His last visit was in 1887, soon after his return from which he was struck with paralysis, and died on the 30th of the following January, on his seventy-eighth birthday.

Dr. Gray married, in 1858, Jane, daughter of C. G. Loring, of Boston, and had no family. He was a correspondent of the Institute of France, a Doctor of Laws of Oxford and Edinburgh, and a Doctor of Science of Cambridge. He was elected foreign member of the Linnean Society in 1850, and of the Royal Society in 1873. He was a fellow or correspondent of the principal Continental scientific academies, and had served as President and for sixteen years as Corresponding Secretary of the American Academy of Arts and Sciences, and of the American Association for the Advancement of Science, and he was a Regent of the Smithsonian Institution. He is credited down to the year 1873 with no fewer than 107 papers in this Society's Catalogue of Scientific Papers, and with upwards of 350 scientific works and papers in a chronologically arranged catalogue of these, appended to the 36th volume of the 'American Journal of Arts and Sciences' (September, 1888).

J. D. H.

SIR WILLIAM O'SHAUGHNESSY BROOKE, F.R.S., died on the 8th of January, 1889, at Southsea, after a short illness. He was born in Limerick in 1809, and was therefore in his 80th year. His original

name was William O'Shaughnessy, but he took the name of Brooke on the death of a relative of that name. He graduated as M.D. at Edinburgh in 1833, and shortly afterwards joined the Bengal Army as Assistant Surgeon. He was promoted to Surgeon in 1848, and to Surgeon-Major in 1858. In 1835 he was appointed Professor of Chemistry in the Medical College at Calcutta. From 1844 to 1851 he acted as Assay Master of the Calcutta Mint. He was of a scientific turn of mind, and took readily to the experiments made by Cooke and Wheatstone in telegraphy in 1837. He made some experiments in submarine telegraphy across the Hooghly, at Calcutta, in 1839, and he was the first to introduce the telegraph into India. In 1852 he was appointed Superintendent-General of Telegraphs in India, and he retained that post until 1862, when he resigned and retired from the Indian Medical Service. He was the author of several papers on scientific and engineering subjects, many of which appeared in the Journals of the Asiatic Society. He was knighted for his valuable services in establishing the service of telegraphs throughout India, and he was elected a Fellow of the Royal Society in 1843.

W. H. P.

WALTER WELDON, F.R.S.; born 31st October, 1832; died 20th September, 1885. Very little is known of the early history of the subject of this memoir, beyond the bare facts that he was born at Loughborough on the 31st October, 1832; that he was the eldest son of a manufacturer in that town, and was employed for some years in his father's business; that while so occupied he discovered a taste for literature; and that, in his twenty-second year, he left his native town, and arrived in London determined to make his way as a journalist. With him he brought his young wife, whom he had just married, and who was destined to be his never failing source of consolation and encouragement during those early years of difficulty and adversity which are invariably experienced by a young man beginning an independent life under such circumstances. Young Weldon most certainly had his full share of dark days; and in speaking of them in after life to those who knew him well, he loved to dwell on the sustenance and encouragement he had derived from his devoted wife. Apart from this, however, he was endowed by Nature with a variety of gifts, any one of which might have enabled him to acquit himself well in the battle of life, the combination of which was irresistible, and served not only to raise him to a position of distinction and honour, but to render him capable of performing work which has undoubtedly been, and will probably long continue to be, a benefit to civilised humanity.

Mr. Weldon's first journalistic work was done in connexion with

'The Dial,' afterwards incorporated with 'The Morning Star,' now dead, but in its time a Liberal daily paper of some importance. While thus engaged, he conceived the idea of issuing, at a price which should bring it within the reach of all, a monthly journal devoted to recording current progress in literature and science—subjects which were ever twin sisters in his mind. The connexions he had as a journalist made among writers and scientists on the one hand, and country booksellers on the other, put the production and issue of such a work within his power; and that there was likely to be a demand for such information as he sought to give he felt convinced from his own youthful needs and experiences. His purpose was that the periodical should be issued in London under his own name, and simultaneously in various provincial towns, in each case as the journal of any local bookseller who should subscribe for a certain number of copies. Accordingly, the first number of 'Weldon's Register of Facts and Occurrences in Literature, Science, and Art' was published in London on the 1st August, 1860, at the price—moderate, even when compared with the cost of such periodicals at the present time—of 6*d*. Its proprietor spared no effort to render the work valuable and attractive to those who sought its pages, and secured for it contributions from many men then or since distinguished in science, letters, or art. But those were not the days of an earnest popular desire for such information as 'Weldon's Register' sought to impart, and, without such a demand, at so low a price, it had no chance of success. Consequently, after an existence of some three years, it was abandoned by its projector, who now turned his attention to another and strangely different object.

The practical failure of an ardently cherished scheme, the abandonment of work for which he rightly considered himself specially fitted, was no doubt a severe blow. But Mr. Weldon knew not failure in the ordinary sense. To come short of success in one way was, with him, but an incentive to seek it with redoubled vigour in another. No one could know him well and observe him closely without recognising not only the great scope of his talents, but also the marvellous avidity and thoroughness with which he grasped any subject upon which he brought his mind to bear. In him, moreover, a strong and active mind was allied with constitutional power and a capacity and love for work which it is the good fortune of but few to possess. This is the simple and only explanation of the astonishing fact that, without any education in science, without any technical training, without the advantage to be gained by attending lectures or watching the performance of experiments—with nothing to help him through but his genius and the knowledge he could acquire by sheer hard reading at the British Museum—Mr. Weldon now attacked the problems and difficulties of industrial chemistry. Why he turned

his attention to a task so different from all his previous occupations cannot be stated with certainty. In an admirable memoir of him, published in the 'Journal of the Society of Chemical Industry' in October, 1885, it has been suggested that he derived his first impulse to this new work from his friend the late Charles Townsend Hook, the well-known paper maker of Snodland; and the writer has good reason to believe that the suggestion is well grounded. From whatever cause, Mr. Weldon, from that time to the very hour of his death, devoted himself, with all the earnestness, zeal, and energy of which he was capable, to the study of industrial chemistry, and of the chlorine and alkali manufactures in particular. He thoroughly mastered his subject in all its details, whether from a scientific or a business point of view, insomuch that during the last ten years of his life he was regarded as the highest authority upon it, not only in England, but wherever the manufacture of alkali was carried on. It may safely be averred that, so long as the practice or the memory of this industry shall last, so long will the name of Walter Weldon be honourably associated with it.

The great work of his life, his process for the perpetual regeneration of the manganese oxide used in the production of chlorine from the hydrochloric acid which is the by-product of the Leblanc soda process has been so often described, and is so widely known, as to need no detailed explanation here. No better description of it exists than that, written by the hand of the inventor, published in the 'Journal of the Society of Chemical Industry,' Sept., 1885 (vol. 4, p. 525). Suffice it to say that it produced a revolution in the industry which it affected, supplanting a method of working at once crude, wasteful, and noxious; that it has saved an expenditure to this country of about £750,000 per annum since it has been in operation; and that it has been one of the chief factors in bringing the purchase of bleached fabrics—linen, calico, paper, &c.—well within the power of the poorest classes. To *invent* a good and workable chemical process, however, is not sufficient; and it was perhaps as an *exploitant* and as a man of business (though without a trace of the sordid attributes of the mere *business man*), in the power of fixing the interest, influencing the minds, and attracting the sympathies of those with whom he had to deal, that Mr. Weldon specially excelled. But for these powers, it is doubtful whether his process—so advantageous in its use, and so facile in its working—would ever have been put into practical execution. With all these advantages, it required many years of arduous and anxious work—not to mention the taking of many patents—before Weldon's process became, what it still is, the almost universally adopted method of producing chlorine.

Patented in 1866, and temporarily experimented with soon after-

wards at the works of the Walker Alkali Company, on the Tyne, it was not until late in 1868 that Weldon's regenerated-manganese chlorine process was in operation on a manufacturing scale, at the works of Messrs. J. C. Gamble and Sons, at St. Helens. By the end of 1870, however, out of about forty chlorine makers in the United Kingdom, thirty-five had taken licences for its use, seventeen plants being then either actually at work or on the point of completion. But a formidable rival now arose, in the shape of Mr. Deacon's process for producing chlorine by passing hydrochloric acid gas over masses of pumice stone heated to a certain temperature and saturated with cupric sulphate. Questions of cost apart, the chief merits of this process were (1) its great simplicity; (2) that, per unit of NaCl, it yielded a larger proportion of chlorine than did the Weldon lime process. To meet it, Mr. Weldon again attempted to work the process which he had patented contemporaneously with his lime process, for treating manganese chloride residues by magnesia, so as to recover in the form of hydrochloric acid the proportion of chlorine otherwise lost as calcium chloride. But the Weldon lime process withstood the attacks of all competitors, and by the end of 1875 it had been adopted by every chlorine manufacturer of importance throughout Europe. From the time of the introduction of his chlorine process until the end of 1881, when the patents for it were about to expire, and when his active and pecuniary interest in it ceased perforce, Mr. Weldon was constantly occupied in travel and work connected with the setting up of installations in all parts of the United Kingdom and the Continent, and in devising minor improvements in working. The spring of 1882 brought him relief from this kind of work, but no leisure. Moreover, he had recently suffered the severest bereavement that can befall a man: the sudden death of his younger son, Dante, had been followed only a few weeks later by that of one of the best wives that ever graced an English home. He now, too, began to feel severely the effects of that overwork and unsparing exposure of himself in the cause of duty which had been going on for fourteen years, sapping a constitution once of the most robust.

Many men in his position, under the combined influences of success and sorrow, would now have been content to retire more or less from the active work of life: not so Mr. Weldon. Indeed some of the most useful, and possibly the greatest, work of his life was yet to be accomplished. During 1881 he had been conspicuous as one of the founders of the Society of Chemical Industry—a Society already the most useful, the most successful, and, with one exception, the largest of its kind. To the development and successful working of this Society he devoted an infinite amount of loving labour and thought, whether as member of its Council, as Chairman of its London section,

or as President, which last position he filled from July, 1883, to July, 1884. To the meetings of this Society he contributed many important papers, all bearing on the industry which he had made his special study, and some of them—notably that “On the Present Position of the Soda Industry” (8th January, 1883); his Presidential Address (9th July, 1884); and that on “The Proposal to Raise a Memorial to Nicolas Leblanc” (5th March, 1885)—of such literary as well as intrinsic merit as to create a deep and lasting impression on those who heard or read them.

It may truly be said of Mr. Weldon that he was always working and always learning. Every hour spent in travel, every hour that could be snatched from actual pen-work (for, until the last three years of his life, he did nearly the whole of the vast correspondence incidental to his position with his own hand, often spending some ten hours a day in sheer writing) was devoted to the planning or studying out of new chemical processes or improvements on old methods. From the earliest years of his chemical work, as has been shown above, he had cherished and laboured at the idea of a cheap and practicable magnesia-chlorine process; and he was now to have the satisfaction of arriving at a solution of the problem from a chemical point of view, and also of seeing the mechanical difficulties of such a method in a fair way to be mastered by the engineering skill of his close friend and *collaborateur*, Monsieur Pechiney. This new chlorine process—which its inventor confidently expected to produce as great a revolution in the alkali trade as had resulted from the adoption of his lime-manganese process twenty years ago—was fully described by Mr. Weldon in his memorable address to the Society of Chemical Industry, at Newcastle, on the completion of his Presidential year, in July, 1884; and again in the Journal of that Society for September, 1885. It may be briefly described as follows: Solution of chloride of magnesium—obtained either by the neutralization of hydrochloric acid by magnesia, or by decomposing the residual ammonium chloride of the ammonia-soda process by magnesia; or as the Stassfurt native salt—is evaporated down to a certain point. Sufficient magnesia is then added to produce a solid mass containing about six equivalents of water. This mass is further dried and is then crushed into morsels of about the size of a walnut, which morsels are subjected to a current of air in a special furnace, invented by M. Pechiney, the result being that nearly the whole of the chlorine present is evolved, partly in the free state and partly as hydrochloric acid. The process has been in regular operation at the works of Messrs. A. R. Pechiney et Cie., Salindres, since July, 1887, with highly satisfactory results.

Mr. Weldon was well known as a regular attendant at the meetings of the British Association, and as a frequent contributor of papers to

Section B. Indeed, the last labour of his life, his work 'On the Ratios One to Another of the Atomic Weights of the Elements,' Chapter I of which, "The Glucinum Family," was printed only a few days before the Aberdeen Meeting of 1885—was done with a special view to its consideration by the members of the Association. At what cost *he* went to Aberdeen, in September, 1885, none but the few friends who saw him there can realize. But he had never missed one of the meetings of the British Association since he first attended with Mrs. Weldon in 1865, and nothing could shake his resolve to go. So, though overwhelmed with work and full of bodily pain, he hurried from Germany, and, disregarding the remonstrances of his friends, went straight on to Aberdeen; but only to break down completely on arriving there. After remaining for eight days a prisoner in his hotel, he determined to return alone to his home in Surrey. There he arrived on the 16th September, in such a condition as to inspire the gravest alarm in his friends. Much too late, he now sought that relief in complete rest which he had been entreated to take for years past, doing nothing more during the next three days than dictate a few short letters to old personal friends. In one of them he said: "All work of all kinds is forbidden me—a prohibition which, of course, I shall not be able to obey. But the change which I have so long dreaded is certainly come at last. I had trusted to be able to keep in harness to the very last; but they tell me that a day's work such as I have been accustomed to all my life would be simply suicide, and that of course is not permitted." Late on the afternoon of the 19th, the writer left him in the full belief that he was really better; but the presaged change had indeed come; for at 9 o'clock the next morning he was summoned back to that bedside, only to find that the spirit had already passed away.

For his many and valuable services to chemical industry, Mr. Weldon received the following distinctions: In France, the Great Medal of La Société d'Encouragement, and the Chevaliership of the Legion of Honour. In this country, he was elected a Fellow of the Royal Society (in 1882), Vice-President of the Chemical Society, Vice-President of the Institute of Chemistry, and President of the Society of Chemical Industry.

F. W. R.

THE late SIR JULIUS VON HAAST was born at Bonn, in Germany, on the 1st May, 1824, his father being a wealthy merchant of that city.

After passing through the grammar schools of Bonn and Cologne, the subject of our memoir entered the University of Bonn, and devoted a considerable portion of his time to geological and mineralogical studies. After leaving the University, he spent some years

in France. He afterwards made extensive journeys over many parts of Europe, visiting Russia, Austria, and Italy.

A large firm of shipowners, who wished to direct the stream of emigration from Germany to New Zealand, made him an offer to visit that colony on their behalf, for the purpose of ascertaining its fitness as a field for emigration, an offer which Mr. Haast accepted. Arriving at Auckland in December, 1858, he met Dr. Ferdinand Hochstetter, of the Austrian "Novara" Exploring Expedition, who had just undertaken a geological examination of the North Island on behalf of the Colonial Government. The financial state of the colony at that time, and the disturbances with the Maoris, at once convinced Mr. Haast that it was hardly a suitable field for his countrymen. He accordingly terminated his agreement and joined Dr. Hochstetter's expedition through the North Island. He was subsequently employed by the Provincial Government of Nelson to explore the western and southern portions of that province. With only four companions, he started on an expedition which took him away from civilised life for a period of eight months. During this journey, in addition to the discovery of the Grey and Buller coal fields, and of several gold-bearing districts, he filled in the topography of a large part of Nelson, and added largely to the knowledge of the geology, as well as the fauna and flora, of these alpine portions of New Zealand. On his return, the Government published a full report of the journey, and of the scientific and other discoveries which had been made. This report attracted some attention in Europe, and the Royal University of Tübingen, in 1862, bestowed upon the author the honorary degree of Doctor of Philosophy.

The undoubted success of this Nelson enterprise induced the Canterbury Government to offer Dr. Haast the position of Provincial Geologist. Accepting the offer, he commenced work by similarly investigating the topography and mineral resources of the western ranges of that province. After several years of continuous labour this work was carried to a successful issue, and the practical results were embodied in a voluminous Report on the Geology of the Provinces of Canterbury and Westland. Years before the publication of this complete report the detached accounts of Dr. Haast's explorations were very favourably received and commented on. Sir R. Murchison, the President of the Royal Geographical Society, thus referred to them:—"He was proud to preside upon an occasion when a gentleman, who was a geologist by profession, had proved himself to be a good geographer, and had shown how intimately the subjects of physical geography and geology were united. Dr. Haast's labours were worthy of all commendation." To the general reader the book is a highly interesting and instructive one. The very large amount of geological detail, and the breadth and completeness of the author's

generalisation as to the stratification and the mode of formation of the Southern Alps, their subsequent carving and denudation by ice and water, the evidence of a glacial epoch similar to that which produced the striæ and boulders of Europe, as well as the account given by him of the nature of Canterbury's rivers and the formation of its plains, all testify to the industry and acute observation of this learned *savant*. He was elected a Fellow of the Royal Society in 1867. Some fifty academies and learned societies in various parts of the world enrolled him as a member. The Emperor of Austria conferred upon him a patent of hereditary nobility; and, besides receiving several foreign orders, he was created a C.M.G. by Her Majesty. In 1876 he was appointed Professor of Geology to the Canterbury College, New Zealand University; and in 1880 he was elected a member of the Senate. During his explorations as Provincial Geologist, he commenced the formation of the Canterbury Museum, which, although of such recent growth, has now attained such proportions as to be classified by competent authorities as about the thirteenth in rank of the museums of the world, whilst it undoubtedly is the finest in the southern hemisphere. In 1886, Dr. von Haast came to England as one of the Commissioners for the colony at the Colonial and Indian Exhibition; and for his services on that occasion was promoted by Her Majesty to the rank of K.C.M.G. In 1887 he returned to New Zealand, with his wife and daughter, and died somewhat suddenly of heart disease soon after his arrival at his Canterbury home.

W. L. B.

The task of writing an obituary notice of the late Dr. C. J. B. WILLIAMS is rendered comparatively easy by the fact that about four years before his death this venerable physician published full memoirs of his life and work, which have saved much trouble and time in ascertaining the various incidents of his career.

Dr. Williams, born in 1805, was descended from Welsh parents; his father was the Rev. David Williams, Perpetual Curate of the Collegiate Church of Heytesbury, in Wiltshire, and his mother was the daughter of a surgeon, Mr. Williams, who lived at Chepstow. This lady received some instruction from the late Mrs. Hannah More, who, strictly religious as she was, often took her pupils to witness the acting of Garrick, which she considered an important aid in education. His father, engaged at one period of his life in tuition, especially in the preparation of students for the Universities, when he ceased to receive pupils still conducted the education of his sons; but, although Dr. Williams' brothers were afterwards sent to public schools, he himself completed his education at home under his father's superintendence until he entered the University of Edinburgh. Dr.

Williams seems to have made fair progress in classical learning, but never advanced far in this direction, his mind being interested more in the natural sciences; in after years he came to the conclusion that having had the power of directing his mind for some years to the subjects he liked most was in his case productive of much good, and enabled him to develop his power of originality, which might probably have remained for ever latent had he undergone a rigid course of training in any public school during that period of his life. The writer thinks that frequently this has proved true, and that many of our most original discoverers and advancers of knowledge would have failed to attain great eminence had they been obliged for some of the best years of their lives to pursue studies uncongenial to their tastes.

During his stay at home there is one incident in connection with his amusements which may have had some influence over his future acoustic studies; he says he was very fond of birds and animals; he had his pets and used to spend a good deal of time in the poultry yard, and made a special study of the language of cocks, hens, and chickens, ducks and drakes, turkeys and geese, and in short of all domestic animals, and having a nice ear and considerable power of mimicry, he learnt their various notes, and was able to imitate them well enough to influence the creatures towards him as if he had been one of themselves; he remarks that "the brute utterances have all their meanings, and are expressive of various feelings, whether pain or pleasure, anger or love, fear or confidence, defiance or submission, and are mutually intelligible among different animals as words are among human beings."

In the autumn of 1820, Dr. Williams went to Edinburgh as a student of medicine, studied chemistry under Dr. Hope with much pleasure, and anatomy under Professor Monro (*tertius*) and Dr. Barclay with much less satisfaction; he remarks that at that time the teaching of anatomy was very different from what it is at present, from the absence of plates and manuals; there also he studied botany during the summer, and medical jurisprudence under the late Sir R. Christison. At the same time he commenced his attendance at clinical lectures and hospital practice, and became a pupil and great admirer of Dr. Alison, the Professor of the Institutes of Medicine.

In the autumnal vacation, Dr. Williams returned home, the only holiday he had during the period of his medical studies, and in this vacation he was not without amusing resources. He was occasionally gratified by a visit to the theatre, and at different times witnessed the performances of Edmund Kean, Charles Young, Macready, Charles Kemble, the elder Matthews, and of Mrs. Henry Siddons, Miss Stephens, and Miss Paton.

Before leaving Edinburgh, Dr. Williams read a paper at the Royal

Medical Society (1823), afterwards published as a separate thesis, entitled "On the Blood and its Changes by Respiration and Secretion," embodying the views of Lagrange modified by further research, in the three following propositions:—

1. The difference in composition between arterial and venous blood consists chiefly in this, that the former contains an additional quantity of oxygen, and the latter of carbonic acid, chemically united with it; the affinity between the blood and the oxygen being more powerful than between the blood and carbonic acid.

2. The oxygen gas of the respired air, pervading the walls of the pulmonary vessels, displaces by virtue of its superior affinity an equal bulk of carbonic acid gas, and thus converts venous into arterial blood.

3. In the course of the circulation, the oxygen thus absorbed gradually attracts carbon from the proximate principles of the blood, and uniting with it produces heat, and by thus also forming carbonic acid converts the blood from arterial into venous.

The second part of the essay is devoted to the subject of animal heat, and Sir Benjamin Brodie's experiments are referred to and commented upon.

The author thinks that in this essay, written in 1823, he may be allowed to have anticipated by many years some of the views of Dumas and Liebig with regard to the changes in the blood through respiration.

Soon after taking the degree of M.D. at Edinburgh, Dr. Williams went to Paris, and there became acquainted with the physiologist Majendie, and saw many very eminent men of science, as La Place, Vauquelin, Ampère, Humboldt, Cuvier, Arago, Gay-Lussac, &c., and at the commencement of the Medical Session determined to make the Hospital of La Charité and the Clinique of Laennec the chief field of his work. An interesting description is given of Laennec, his slim frame, his weakness, coupled, however, with quickness of perception and intelligence, which enabled him to discover a new system and art for the elucidation of disease. Dr. Williams remarks that his teaching was little valued by the French students, and that his class chiefly consisted of foreigners and but a sprinkling of his own countrymen, these latter being more attracted by the impetuous Broussais, who captivated them by his grand ideas and sweeping hypotheses without troubling them with dry details or the results of careful observations. Dr. Williams also speaks most warmly of the knowledge of pathological anatomy which he obtained from Audral, and remarks that in eight months he learnt more of the subject than he could have done in eight years in the hospitals of his own country. Chomel and Louis were also his instructors, and there can be no doubt that his studies in Paris at this time had a great influence on

his future career, his mind being well fitted to make the best use of all the opportunities he then possessed.

Dr. Williams, speaking of Laennec, remarks that "the chief discoveries of auscultation and its large development were undoubtedly his, and have placed him in the foremost rank among the benefactors of mankind." To these, as well as to his personal teaching, says Dr. Williams, "I owe not only some of the most valuable knowledge that I have ever acquired, but also the opening up of new avenues of knowledge which will be inexhaustible to the end of time. It was the new idea of bringing another sense—the sense of hearing—to aid us in the investigation of the organs in health and disease, and through studying its indications, learning as it were language which would tell us of their changes of condition or motion, that gave vastness to the discoveries of Laennec, and would render them fruitful far beyond his own share in them."

After his return from Paris, Dr. Williams went first to Madeira with a patient, and subsequently for a few months to Switzerland with Lord and Lady Minto, as travelling physician.

After his return from this last journey, Dr. Williams' career as a London physician may be said to have commenced.

He took a house in Half Moon Street, Piccadilly, and devoted much time to preparing a work on Auscultation, chiefly of the lungs, and wrote several articles in the 'Cyclopædia of Practical Medicine,' and afterwards in the 'Library of Medicine;' in the latter work, most of the articles relating to diseases of the respiratory organs were committed to his charge. In his work on 'Auscultation,' his object was to bring in the laws of acoustics in order to explain the various marked phenomena, such as the fine crepitation in pneumonia and metallic tinkling signs which had been discovered, but in no way explained, by Laennec. In his article, "Coryza," in the 'Cyclopædia of Medicine,' the so-called *dry* method of cure was proposed.

Dr. Williams made some observations on slow combustion in 1823, and subsequently gave an evening lecture at the Royal Institution, and a paper was read at the Royal Society; Dr. Williams had always an idea, even when he wrote his Memoirs, that the subject had been shelved by scientific men: he thought it might have an important bearing on spontaneous combustion occurring in coal stores, hay-ricks, &c. The existence of slow forms of combustion, however, is quite recognised and appreciated by chemists and physicists, and the slow combustion of phosphorus must have been known since the discovery of that element.

In 1830 Dr. Williams married a maternal cousin, Miss Jenkins, and from 1828 to 1835 he was engaged in the investigation of the causes of the sounds of the heart, an investigation which was originated in conjunction with Dr. Hope, but unfortunately some

differences arose between him and his fellow-worker, a misunderstanding which afterwards became the source of much discomfort.

In 1835 Dr. Williams was elected a Fellow of the Royal Society, but, as will be shown later on, he disapproved of the existing constitution of that Society, preferring a more popular basis of membership, such as was to be found in the then young British Association.

On the resignation by Dr. Chambers of the Physicianship of St. George's Hospital, Dr. Williams offered himself as a candidate for that appointment, in opposition to Dr. Hope, but he soon retired from the candidature, finding that his chances would hardly justify a continuance of the contest.

In 1839 the Chair of Medicine at University College, with the Physicianship to the Hospital, became vacant by the retirement of Dr. Elliotson, and Dr. Williams secured the post for himself, and had thus an opportunity made for him where he might utilise his acquirements; he gave the Introductory Address at the opening of the Session, which was well received, as the writer of the present notice can testify, he having been one of the audience.

At University College and Hospital his colleagues were Drs. Sharpey, Anthony Todd Thomson, D. P. Davies, Dr. (afterwards Sir Robert) Carswell, Messrs. Liston, Samuel Cooper, and Richard Quain.

In 1840 Dr. Williams was nominated to the Fellowship of the Royal College of Physicians; he became a Fellow, but says he had some doubt as to accepting the honour, being opposed to the method of election of Fellows and to the constitution of the College altogether, and although great alterations were afterwards made by the passing of the Medical Act of 1858, still he always was more or less antagonistic to that body: a fact to which subsequent allusion will be made.

About this time Dr. Williams' attention was drawn to the preparation of his 'Principles of Medicine,' which appeared in 1843 and met with a hearty reception by the Profession.

In 1846 the Pathological Society was founded, and Dr. Williams was made the first President.

Dr. Williams soon became more and more engaged in private practice, and in 1848 resigned his appointment at University College and Hospital and removed to Upper Brook Street, where he remained till the end of his medical career, having been previously ten years in Half Moon Street and eleven years in Holles Street. In the 'London Journal of Medicine,' 1849 (a publication which only existed a very few years), Dr. Williams published a paper on the "Value of Cod-liver Oil in the Treatment of Pulmonary Consumption," and the conclusion arrived at was thus summarised:—

"I prescribed the oil in above 400 cases of tuberculous disease of the lungs in different stages, and of 243 of these have notes. Out of

this number the oil disagreed and was discontinued in only nine instances. In nineteen cases it appeared to do no good, while in the large proportion of 206 out of 234 its use was followed by marked and unequivocal improvement, varying in degree in different cases from a temporary retardation of the progress of the disease and mitigation of distressing symptoms up to a more or less complete restoration to apparent health."

Dr. Williams was by no means the first physician to prescribe cod-liver oil; Dr. Bardsley, of Manchester, had used it for many years, and Dr. Darling and Dr. Hughes Bennett had also anticipated him in the use of this most valuable therapeutic agent.

In 1852 Dr. Williams was telegraphed for to Walmer to see the great Duke of Wellington, but he arrived too late; nevertheless, he attended the State Funeral as a medical attendant of the Duke.

In 1858 Dr. Williams was elected President of the New Sydenham Society, which was established for the purpose of translating foreign works on medical subjects and the re-publication of important scattered papers.

In 1862 Dr. Williams delivered the Lumleian Lectures at the Royal College of Physicians, having previously been Gulstonian Lecturer in 1841.

We pass over the remaining years of Dr. Williams' career as a physician, as the increasing calls of a large practice left him little time for other work of more general interest, only briefly referring to his action for libel against the late Duke and Duchess of Somerset, which ended by his receiving an ample apology, completely clearing his professional character from the aspersions cast upon it in a period of excitement and distress at the loss of her son by the Duchess; and to the publication in 1871 of a work on Pulmonary Consumption, in conjunction with his son, Dr. C. Theodore Williams; and, lastly, his election as President of the Medical and Chirurgical Society, in 1873, and his appointment as Physician Extraordinary to the Queen, in 1874.

In the next year he retired from practice, and made his home at Cannes for the remainder of his life, dying there of pneumonia on March 24th, 1889. After his retirement, among other occupations of a naturally active mind, he spent some time in examining Sun-spots, especially in relation to weather changes, and made many summer visits to England.

This brief account of the life of Dr. Charles J. B. Williams would be very incomplete without the addition of some comments on the man and his work, suggested by the perusal of the Memoirs of his Life. One cannot help seeing that he was a man of unusual ability and of great confidence as to his powers—that he was industrious and persevering, and took full advantage of the opportunities

which were presented to him, of which characteristic a strong instance is supplied by his bringing at once into practical application in this country the powerful aid to diagnosis in diseases of the chest afforded by the stethoscope, whose value he had full opportunity of appreciating during his student career at Paris, as a pupil of Laennec. The frankness of his character is well shown in his treatment of different misunderstandings with professional brethren and others in the pages of his autobiography. He lays as much stress on what makes against himself as on the favourable points, so that where the impartial reader may hold that he was in the wrong he almost disarms hostile criticism at the moment when he arouses it. This frankness may very likely have been the outcome of deep religious conscientiousness, for the whole book, and especially the final chapter, gives evidence of his character in this respect. He knew how to do justice to others as well as to himself.

The reforming instinct of Dr. Williams found material to work upon in the constitution and bye-laws of the Royal Society and the Royal College of Physicians. With respect to the Royal Society, he endeavoured to introduce extensive changes by removing the limit put on the number of Fellows elected annually, and laid much stress on his conviction that, whereas the Royal Society was founded for the promotion of natural science, it had become a kind of club for the segregation of the *crème de la crème* among scientific men from the general mass. But, though a special committee was appointed to consider his proposals for reform, they reported in favour of the *status quo*.

The changes which he proposed in the case of the College of Physicians were of a very sweeping character, as he was eager that all physicians of good repute should be able, without difficulty or delay, to obtain the Fellowship as the full completion of the membership. He wanted the College to take a more commanding position—to become a national institution, fairly entitled to stand at the head of the Medical Corporations of the country and to acquire the authority and influence in the State that should properly belong to it; and he considered that, in order to attain this position, it was necessary for the College to include within its roll of membership many who did not belong to it, though fully qualified, because the privileges of mere membership were small, especially in the case of provincial physicians. But in this case, also, Dr. Williams found no adequate support for his views among the governing body of the institution.

His references to his family exhibit throughout many signs of a very affectionate nature, and one is glad to think that during his later years of ease and retirement such a man had fuller opportunities for enjoying domestic family life than among the bustle and engagements of a successful physician's mid-career.

The man was what his autobiography has shown. What was his work? His chief claim on the memory of his fellow-labourers and the public is that he was prominent among those who helped to reduce the principles of medicine to a properly co-ordinated scientific system, and who laid the foundations of modern pathology. It is pleasant to think that this high claim was fully recognised in his own lifetime, as is shown by his appointment to the different posts of honour already mentioned.

A. B. G.

By the death of Mr. NEWALL, which occurred in April, 1889, the Society has lost a Fellow whose labours and interest in the progress of instrumental astronomy have secured a notable progress, which has been utilized throughout the whole of the civilized world, his activity in this direction being in direct continuation of that of others to whom we owe in a large measure the renaissance of the optical art in England.

One of the first telescopes made by Cooke, of York, in his early days was one of large aperture constructed for Mr. Hugh Lee Pattinson, F.R.S., F.R.A.S., and this was almost the first commission for a large object glass he had received. It was in the satisfactory completion of this telescope that Cooke gave that sure promise of a combined optical and engineering skill which his whole life was destined to fulfil.

Mr. Newall, in 1849, married a daughter of Mr. Pattinson, and, possessing the same interest in astronomical pursuits as Mr. Pattinson himself, frequently discussed with him the possibility of successfully constructing and mounting an object glass of a size much larger than any other in existence. When he saw in the Exhibition of 1862 the two large discs of crown and flint glass, manufactured by the Messrs. Chance, of Birmingham, he determined to acquire them, and try an experiment. The diameter of these discs was about 26 inches; the largest existing refractor at that time in actual operation was the 16-inch at Pulkowa, and Mr. Newall determined to see whether or no it was possible to advance at one bound from an aperture of 16 inches to one of 25. This experiment was not a simple one, for the idea at that time was that even if a perfect object glass of such dimensions could be turned out by the optician's skill, yet that its flexure would render it practically useless for all fine astronomical purposes.

Our great optician, Cooke, was just as anxious to make this experiment as Mr. Newall himself, and he threw himself into the work with vigour. Ultimately the telescope was finished: Cooke had never made an object glass of which the definition was more perfect, while the admirable engineering skill displayed in the mounting and the ease

and simplicity of its motions and working had never been surpassed. Mr. Newall had originally intended to erect this enormous telescope in some climate more favourable for astronomical investigations than our own. Madeira, Egypt, and Malta were thought of, but it was first of all necessary to erect it not far from York in order that various experiments might be gone through without loss of time. It was, therefore, erected at Ferndene, Mr. Newall's residence at Gateshead, and after its completion, circumstances having arisen which prevented its transference abroad, it remained there until Mr. Newall's death.

By Mr. Newall's generosity it was practically at the disposal of anyone who had any special research to make for which a large aperture was indispensable. The writer of this notice would here acknowledge the many opportunities which were afforded him of making such observations, and also for the graceful hospitality with which these opportunities were accompanied.

The success of this experiment at once changed the aspect of the optical art in all countries. The 26-inch at Washington, the 27-inch at Vienna, and the 36-inch in California are the direct descendants of the 25-inch at Gatestead.

Before his death, Mr. Newall was anxious that the telescope should be removed to a more favourable locality, and it was offered by him to and accepted by the University of Cambridge. It is to be hoped that the scientific responsibilities which the University accepts with the instrument will be amply fulfilled.

It may be well understood that the practical sagacity, unswerving purpose, and scientific habit of mind which had led to the conception and final carrying out of such an experiment as this, in alliance with the elder Cooke, would prove fruitful in other fields. Mr. Newall was not only a successful manufacturer, but he may be regarded as one of the chief founders of one of the most important of our modern national industries. In that part of his business which had to deal with wire rope, he found an unmechanical method of working; he left one which is simply perfect, and, as a result, wire ropes of his construction are now found all over the world: the double process of making the strands and then combining them being entirely avoided, while the wires retain all their original strength, as they remain untwisted. He was among the first, if not the first, to see and subsequently demonstrate that the whole question of submarine telegraphy could only be settled by encasing the conducting wires with ropes similar to those he was constructing for other purposes. This, of course, necessitated the use of an insulating material, and Mr. Newall was among the first in this country to study the properties of gutta-percha, insulating the conducting wires by the material, and then surrounding and encasing them with strong wire rope.

The first successful cable laid from Dover to Cape Grisnez, in 1851,

was manufactured by Mr. Newall. After this successful experiment, of course greater lengths were tried. Ships were specially constructed for cable laying, and arrangements adopted for securing the greatest facilities in paying out.

Mr. Newall's sagacity was again shown, and he at once invented methods which have never been improved upon, and which are now universally adopted. In the tank in which the cables were coiled, a cone occupied the centre, and effectually prevented kinks in the paying out, while a "drum brake" was inserted in the paying out apparatus to prevent all undue strains. It has been well said:—"To have established a new industry, to have taken an active part in securing a triumph of applied science which will modify the history of the world, and to have led the way in the development of the refracting telescope is a record of achievement to which few attain, but which does bare justice to the life-work of Robert Stirling Newall."

Mr. Newall was born in 1812. He was D.C.L. of Durham University, and was elected a Fellow of this Society in 1875.

J. N. L.

JOHN PERCY, M.D., who died on the 19th of June last, was born at Nottingham, on the 23rd of March, 1817. At an early age he entered the Medical School of the University of Edinburgh, where at twenty-one he took the degree of M.D. He then studied in Paris, making the acquaintance of the leading French chemists of the time, who doubtless directed his mind towards the line of work to which his life was mainly devoted. He practised medicine at Birmingham for a few years, where, coming in contact with directors and managers of works, he was led to take special interest in metallurgy. It is, perhaps, worth remembering that the connexion between therapeutics and metallurgy has been traditional, and that the critical period of both was the middle of the 16th century, when Paracelsus attempted to introduce order into the science of medicine and Georgius Agricola strove to establish the art of metallurgy on a sound basis.

Dr. Percy's first paper was entitled a "Notice of a New Hydrated Phosphate of Lime," and his second, dealing with the "Management of Monkeys in Confinement," was printed in 1844. It was followed by other papers on medical subjects, but such work soon gave place to the systematic study of metallurgy, in which he might fairly say with an old writer: "An indefatigable labour, the closest inspection, and hands that were not afraid of the blackness of charcoal" had been his "chief masters." There was, indeed, little else than his own patient research to guide him, for the literature of metallurgy up to the time he wrote was sparse in the extreme, as may be gathered from the fact that when Cramer, himself a doctor of medicine, pub-

lished in 1754 his "list of the chief English authors (about thirty in all) who have treated of minerals and metals," none had written a treatise of metallurgy worthy of the name, though there were many detached monographs of value and a few papers in the 'Philosophical Transactions of the Royal Society.' In the period which elapsed, nearly a century, between the publication of Cramer's book and the time when Dr. Percy accepted the chair of metallurgy in the Royal School of Mines and began to teach, the most noteworthy contributions to metallurgical literature were Bishop Watson's Essays. These appeared in 1782, and are fragmentary, but, as Dr. Percy said, "are elegantly and lucidly composed, and I never take them up but with increasing pleasure." In 1861 Dr. Percy published the first volume of his treatise on 'Metallurgy,' which he dedicated "with sincere respect and affectionate regard" to Faraday. This work, which he calls the "task of his life," developed into a series of volumes containing 3,500 octavo pages. It is on this treatise that his reputation mainly rests, and we cannot doubt but that it will be enduring. The writings of Pliny in the 1st century, of Geber in the 8th, and of Agricola in the 16th, may still be read with profit side by side with the modern work of Karsten, Gay-Lussac, Berzelius, Le Play, Plattner, Deville, and Holley, and it is with these metallurgists that Percy takes his place. His writings differ in many ways from those of his predecessors in any country. He was forcibly impressed with the fact that metallurgical problems demand for their successful investigation the exercise of the highest analytical skill, and involve considerations worthy of those who delight in transcendental inquiries. He effectively quotes Réaumur's remark, "*l'utile bien considéré a toujours du curieux, et il est rare que le curieux bien suivi ne mène pas à l'utile.*"

The distinctive character of his metallurgical treatises arises from the care with which he examined the relations of the metals to other elements and to each other. While his predecessors unhesitatingly accepted the statements of earlier writers or showed a tendency to deduce from analogy what these relations would be, he made the properties of metallic compounds the subject of careful experiment and embodied the results in his books, which form a record of great value, and one that teems with suggestions for future investigators. The excellence of the chemical portions of his books gives them great value as works of reference quite apart from the accurate and elaborate descriptions they contain of typical metallurgical processes. These were in all cases prepared by the best men he could find, usually his own students, who were actually engaged in conducting the operations they describe. Such aid was always fully acknowledged. One remarkable feature of these books is that almost every woodcut may be considered to be an accurate though small mechanical drawing, and it is

only measurable drawings of this kind which are really useful in practice. In criticising his writings it may perhaps be said that his dread of mere empiricism and his intolerance of inaccuracy often led him to magnify points which now seem to be somewhat trivial, and he sometimes withholds the expression of his own opinion when the reader has fairly a right to expect his guidance and would be grateful for the support of his authority.

Of all his work that relating to iron and steel is perhaps the most important, and it began early in his metallurgical career with an elaborate piece of analytical work. The first International Exhibition, of 1851, contained a very extensive and highly interesting series of British iron ores, collected with great labour and at considerable expense by Dr. Percy's friend, Mr. H. S. Bakewell, of Dudley, and afterwards presented by him to the Geological Museum in Jermyn-street. Mr. Bakewell placed at Dr. Percy's disposal the sum of £500 towards defraying the cost of analysing the more important of these ores. The work was completed by Dr. Percy with but slender aid from Government, and the results are embodied in his treatise on Iron and Steel, which was published in 1864. They have rightly been described as the first serious attempt at a survey of our national resources as regards ores of iron. With regard to the actual extraction of iron from its ores, his services were not less important. In 1855 the fact was established that pig iron from the blast furnace contains the greater part of the phosphorus originally present in the ore. Dr. Percy pointed out that phosphorus is not eliminated to a sensible degree in the Bessemer process, as it is in the old process of puddling; and he was of opinion that if the Bessemer process was to be "generally applicable in this country, it must be supplemented by the discovery of a method of producing pig iron sensibly free from phosphorus and sulphur with the fuel and ores which are now so extensively employed in our blast furnaces." The practical solution of the problem of eliminating phosphorus in the Bessemer converter, and the wide adoption of a process of truly national importance, are the outcome of Dr. Percy's teaching, for the problem was solved by three of his pupils. The delivery of his eloquent address in 1886, as President of the Iron and Steel Institute, fittingly ended the active portion of his labours with regard to these metals.

His most noteworthy addition to practical metallurgical processes was described in a paper written by him in 1848, and published in the same year in a journal called 'The Chemist.' A translation of this paper reached a distinguished Austrian, who introduced, at Joachimsthal, the process now known as that of von Patara, which depends on the solubility of chloride of silver in hyposulphite of soda. Early in 1884 this process was modified in America, by Mr. E. H. Russell, in order to render it applicable to ores poor in silver, which

also contain a considerable quantity of base metal. Those who have seen this process as now conducted in the Western States of America will appreciate the importance of Dr. Percy's original suggestion. His contributions to our knowledge of metallic alloys were of special value, and he discovered the alloy of copper and aluminium, now known as aluminium-bronze.

He concluded the introductory lecture which he delivered at the Royal School of Mines, more than a quarter of a century ago, by pointing out that "in proportion to the success with which the metallurgic art is practised in this country will the interests of the whole population, directly or indirectly, in no inconsiderable degree be promoted." The recognition of this fact appears to have steadily guided him, and his best services were always at the disposal of the Government and were freely used, as will be seen from the long list of Royal Commissions and departmental inquiries upon which he served. The first of these was the Committee appointed, in 1861, by the Secretary of State for War, to inquire into the "Application of Iron for defensive purposes." This continued its labours for four years, and was followed by a Special Committee appointed in 1867, to inquire into "Gibraltar" shields. He was also a member of the Royal Commission appointed in 1871, "to inquire into several matters relative to Coal in the United Kingdom," and of the Royal Commission of 1875, which investigated "the cause of the Spontaneous Combustion of Coal in Ships."

He resigned his chair at the Royal School of Mines in 1879, but he continued to hold the office of Lecturer on Metallurgy to the Advanced Class of Artillery Officers, at Woolwich. He was also Superintendent of the Ventilation, Warming, and Lighting of the Houses of Parliament. In both of these appointments he took great interest until his last illness. Dr. Percy collected with great care a series of metallurgical specimens to illustrate special points of interest relating to the manufacture and uses of metals. "From the study of it," he said, "I have myself derived much instruction. There are no specimens which, in my judgment, are more instructive than such as exhibit defects which have appeared either in the process of manufacture or in the use of metals." This collection was formed while Dr. Percy was at Birmingham and during the period of twenty-nine years he was Lecturer on Metallurgy at the Royal School of Mines. The specimens are of great interest and value, and, as in many cases they represent obsolete processes, no similar specimens could again be obtained. They are all minutely described by labels, many of which bear incidental references to Dr. Percy's Treatise on Metallurgy, to official reports, and to technical literature. It may safely be asserted that no existing metallurgical collection can compare with this in interest and importance. It is fortunate, therefore,

that it will not be dispersed, but, in accordance with the wishes of Dr. Percy's family, will be preserved in connexion with the School of Mines, where he taught so long, and exhibited to the public at South Kensington, as the "Percy Collection."

The most cursory examination of his writings will serve to show the rigid precision with which he wrote. Sometimes when his sympathy or indignation was aroused he would adopt a more florid though not less effective style, of which it would be difficult to find more characteristic examples than the two extracts here placed in conjunction, both relating to the exhaustion of our national supply of coal, and both being exponents of his patriotic wishes for the welfare of his country. Speaking of a well-known coal-field, he says, "This magnificent bed of coal has been most barbarously treated. The pits have generally been worked by contractors under the superintendence of viewfers, called ground bailiffs. In consequence of the rapacity and rascality of many of the former, and of the ignorance, inattention, and fraudulent connivance of many of the latter, an enormous amount of coal has been irremediably lost to the nation." After an interval of ten years he said, in concluding his Presidential Address at the Iron and Steel Institute, "There is a question which must often occur to us, namely, what will Great Britain be when our vast reservoir of material force, coal, is exhausted The time must come when, in consequence of that exhaustion, Great Britain will cease to be a great manufacturing nation, . . . but, however mournful and unwelcome this proposition may be, we have the satisfaction of knowing that we are now laying the foundation of prosperous and mighty kingdoms in various parts of the world which we hope will be the strongholds of virtue, of order, and of freedom The glory of old England may, after all, not depart; on the sites of the soot-stained Birminghams and Manchesters new and splendid cities may arise where the merchant princes, of Anglo-Saxon descent, from the remotest parts of the globe shall rejoice to dwell and end their days in peace."

Dr. Percy's public utterances were but few, and the above formed a part of the last of them. He led a retired life and was hardly ever seen at Scientific Societies, though he was frequently at the Athenæum and was well-known at the Garrick Club.

He married in June, 1839, Miss Grace Mary Percy, the only daughter of Mr. J. E. Percy, of Warley Hall, near Birmingham. Those who knew him best feel that the loss of his wife, in 1880, greatly changed him.

Official recognition of his admirable labours there is none to record, but many Scientific Societies and Institutions conferred on him their membership. He was elected a Fellow of the Royal Society in 1847, and served on its Council in 1857-59; he was awarded the Millar Prize

of the Institution of Civil Engineers, of which body he was one of the few Honorary Members. He received the Bessemer Gold Medal of the Iron and Steel Institute in 1877, and, in 1889, the Prince of Wales, on the recommendation of the Council, awarded him the Albert Medal of the Society of Arts. The notification of the honour reached him on his death-bed, and he received it with the characteristic remark, almost his last, "My work is done."

W. C. R-A.

ADMIRAL SIR ROBERT SPENCER ROBINSON, K.C.B., was the youngest son of the late Venerable Sir John Robinson, Archdeacon of Armagh. Born in January, 1809, he entered the Navy 6th December, 1821, served in the boats of the "Sybille" in an affair with pirates in 1826, and became a Lieutenant in 1830. He attained the rank of Commander in 1838, and that of Captain in November, 1840. After commanding in the latter rank H.M.S. "Arrogant," "Colossus," and "Royal George" on foreign service, he was Captain of the Steam Reserves at Plymouth and Portsmouth for four years, until he became a Rear-Admiral, in 1860. He was a Commissioner to enquire into the management of the Royal Dockyards in the same year, and was appointed Controller of the Navy on 7th February, 1861, an office he held until 1871. The latter three years of this period he was also a Lord of the Admiralty. He retired in 1871, and died on the 27th July, 1889. He was the author of a treatise on the Marine Steam Engine. Sir Spencer was at the head of the constructive department of the Admiralty during a period of momentous change, when iron was being introduced in place of wood; the powers of the steam engine were being rapidly developed, and armour-plating was becoming a necessary protection to the battle ship. Having already profited by a scientific training, superior to that which in his day was common among naval officers, in one of the intervals of his naval employment by the Admiralty, he found an opportunity of entering the marine engine works of the late Mr. Robert Napier, on the Clyde, and there practically acquired the art of using engineering tools and of conducting factory work—acquirements which proved invaluable to him afterwards during his superintendence of the Steam Reserves, and subsequently of H.M. Dockyards. His service at the Admiralty, as Controller of the Navy, was distinguished by a combination of ability and devotion to duty well adapted to accomplish the solution of the great naval problems which it was his lot to grapple with, and indeed to solve. It was due to his influence, and largely to his initiative, that the British Navy became possessed of a fleet of iron-built armoured ships long before the necessity for giving up wood-built ships of that class was realised in other countries. He similarly anticipated foreign navies by the early introduction of the

compound marine engine; and throughout his period of service the British Navy led the way in the development both of armour and of ordnance. He was an accomplished linguist, and possessed great literary ability and aptitude.

W. J. J. W.

CHARLES SPENCE BATE was born at Trenick, near Truro, on the 16th of March, 1818. He was the elder son of Mr. Charles Bate, who practised as a dentist at Plymouth. He received his education at the Truro Grammar School, and afterwards was for two years in the surgery of Mr. Blewett. He then gave himself to the study of dentistry with his father, and on becoming qualified, commenced practice in Swansea, in 1841. Here he acquired a good practice, and by association with the scientific men of the place his taste for those branches of natural history with which his name was afterwards so closely associated was fostered and developed. After a residence of ten years in Swansea, Mr. Bate returned to Plymouth, where he succeeded to the dental practice of his father. In his profession he stood very high, enjoying a great repute for skill both in its purely surgical and mechanical branches. He contributed numerous papers on dental subjects to the 'Lancet,' the 'Medical Times and Gazette,' the 'British Journal of Dental Science,' and the 'Transactions of the Odontological Society.' He was President of the British Dental Association in 1883, of the Odontological Society of Great Britain in 1885, and of Section XII of the International Medical Congress held in London in 1881. As a naturalist Mr. Bate's favourite study was the Crustacea, and in the development and morphology of this group he did most of the work by which his name will long be remembered. The work which first brought his name prominently before the scientific world, was the 'Natural History of the British Sessile-Eyed Crustacea,' in the production of which he was associated with Professor Westwood. The difficulties of a work like this—embracing as it did so large a field in which but little had previously been done—were very great, and it cannot be wondered at that some of its conclusions and observations have already been superseded by others made under more favourable circumstances and with all the advantages of added experience and increased facilities of research. Still, however, this work remains the standard authority on its branch of Carcinology. Mr. Bate's most recent work was his report on the *Crustacea Macrura* of the "Challenger" Expedition. This laborious and comprehensive work occupies two large volumes of the Official Report of the Expedition, and is illustrated by 150 lithographic plates, almost all of them drawn by Mr. Bate. These are admirably done and of themselves form an enduring monument to the conscientious industry and

scientific acumen of the author, while the descriptive part of the work is marked by that thorough familiarity with the subject, which characterised his previous great work on the Sessile-Eyed Crustacea.

Mr. Bate contributed to the 'Proceedings of the Royal Society' papers "On the Development of *Carcinus Mænas*" (1856-57), and "On the Development of the Crustacean Embryo and the Variations of Form exhibited in the Larvæ of 38 Genera of Podophthalmia" (1876). In the 'Philosophical Transactions,' 1858, appeared a memoir, "On the Development of Decapod Crustacea." These papers well show the interest which he took in the remarkable transformations undergone by the young of Crustacea, and the important share which he had in the elucidation of them. To the 'Proceedings of the Zoological Society,'—of which Society he was elected a Corresponding Member in 1865—Mr. Spence Bate contributed several papers descriptive of new species of Crustacea.

Mr. Bate was one of the founders of the Devonshire Association for the Advancement of Science, Literature, and Art, was its first Senior General Secretary in 1862, and its President in 1863. In this Society he always took the keenest interest, and he contributed to its Proceedings many papers, chiefly connected with local archæology. He was a most active member of the Plymouth Institution, was twice President of that body, and delivered before it many lectures on biological and archæological subjects. He was also deeply interested in the Fine Art Society of Plymouth, and being a good amateur artist in water-colours, he contributed frequently to the exhibitions held by that Society.

About two years before his death Mr. Bate partially retired from his dental practice, having previously purchased a country residence,—"the Rock," at South Brent—where he died after a brief illness on Monday, the 29th of July, 1889, aged 71 years. He was twice married. His first wife was Miss Emily Amelia Hele, of Wellad Lake, near Ashburton. His second wife survives him. He also leaves two sons of the first marriage,—Captain C. McGuire Bate, of the Royal Engineers, and Dr. Hele Bate, of London; and a daughter, Miss Emily Harriet Bate.

G. S. B.

JOHN FREDERIC BATEMAN, a son of Mr. John Bateman, of Ockbrook, Derbyshire, was born the 30th of May, 1810. His mother was the daughter of the Rev. Benjamin La Trobe, an eminent Moravian minister in Yorkshire, in compliment to whom his grandson, late in life, assumed the name of John Frederic La Trobe Bateman.

At fifteen years of age he was apprenticed to a surveyor and mining engineer of considerable practice at Oldham, and made such progress that he was able to commence business on his own account, as an

engineer, at Manchester, in 1833. Here he had the good fortune to make the acquaintance of the eminent engineer, Mr. Fairbairn (afterwards Sir William Fairbairn, Bart., F.R.S.), who quickly saw the young man's merits, and formed a warm friendship with him, which resulted some years later in the marriage of Mr. Bateman with Mr. Fairbairn's daughter Anne.

In 1835 Mr. Fairbairn was applied to by the millowners on the River Bann, in County Down, Ireland, to examine the locality, and to report on the best means of improving the water power, which was in a very unsatisfactory state. Knowing that his young *protégé* had paid attention to water questions, he thought this would be a good means of bringing him forward, and he accordingly undertook the commission, associating Mr. Bateman with him in the work. In January, 1836, a report was published, signed by Mr. Fairbairn and Mr. Bateman jointly, giving full scientific calculations as to the hydraulic elements of the case, and recommending the construction of large reservoirs, and other works. An Act of Parliament was at once obtained, and in the course of the three following years the works were carried into execution, the designing and construction of the whole being entrusted, at Mr. Fairbairn's request, entirely to Mr. Bateman.

This work established Mr. Bateman's reputation as a hydraulic engineer, and led a few years later to his employment on a much larger and more important work, namely, the provision of an entirely new water supply, on the largest scale, for the city of Manchester. The town had previously been supplied by a private Company from sources near the town, but about 1844, when public attention became prominently directed to the sanitary condition of large towns, the supply was found so defective, that it was evident some extensive improvements must be made, and in that year Mr. Bateman was requested to advise the Company generally on the matter.

In the course of his work on the Bann Reservoirs, and in some subsequent practice in the Lancashire district, he had paid great attention to the mode of supply by impounding the rainfall in hilly districts, and to the data necessary for determining the capabilities of the system. He had become acquainted with the country surrounding Manchester, and had formed a strong opinion that the best source of supply would be by an application of the system to the hilly district lying to the east of the town, and in June, 1846, he made a report strongly recommending this scheme. He said:—"Within ten or twelve miles of Manchester, and six or seven miles from the present Gorton Reservoir (then supplying the town), there is a tract of mountain land abounding with springs of the purest quality. The physical and geological features offer such peculiar facilities for the collection, storage, and supply of water for the use of the towns in the plains

below, that I am surprised they should have so long been overlooked. There is no other district within reasonable limits, nor any source from whence water may be obtained, which will bear comparison with it."

The project as thus designed was on a small scale, suited to a Company who could not contemplate a large expenditure; but even this was considered too bold, and the measure, after encountering violent Parliamentary opposition, was abandoned.

A year or two afterwards the Corporation of Manchester determined to take the supply into their own hands, and Mr. Bateman was called in again by them. This time, however, being encouraged by the larger views that prevailed, he laid out a much bolder scheme, going at once into the heart of the district known as the valley of Longdendale, to which his views had already been directed. His plan was adopted by the Corporation, and was sanctioned by Acts of Parliament in 1847 and 1848. The municipality having arranged to buy up the old Company, the new works were put in hand. At first only such portions were executed as were absolutely necessary, but they were enlarged from time to time, as the demand increased, and it was not till 1877 that Mr. Bateman could report that they were completed, and that the water-bearing capabilities of the district were fully realised.

The work thus created under Mr. Bateman's hand was certainly a magnificent specimen of engineering power and skill. It consisted chiefly of a series of large artificial impounding lakes, extending over seven miles of the valley. Their aggregate content was 735,000,000 cubic feet, and they furnished water for nearly a million of people, as well as a very large and ample water compensation to the millowners on the stream. The total expenditure was about £3,000,000.

In addition to the reservoirs, the works comprised a multitude of subsidiary works for conveying and distributing the water, and for the regulation of the streams. Among these were several novel hydraulic contrivances of a high order; one an arrangement for the automatic separation of the clear from the peaty water (the former being sent to the town, and the latter stored for compensation), and another a mechanical gauge basin, by which the quantity of compensation water could be actually measured at any moment with great accuracy, for the satisfaction of the millowners.

Mr. Bateman was always justly proud of this his first great work; and one of the latest of his life's occupations was to prepare a handsome volume,* putting fully on record its entire history, and giving an

* "History and Description of the Manchester Waterworks." By John Frederic La Trobe Bateman, F.R.SS. L. and E. London and Manchester, 1884.

excellent description, profusely illustrated with engravings, of the various engineering constructions it contained.

In 1852 Mr. Bateman was applied to by the Corporation of Glasgow to advise them in regard to their waterworks. Many schemes had been proposed, but Mr. Bateman recommended them to obtain a supply from one of the most celebrated of the Scotch lakes, Loch Katrine. Parliamentary sanction was obtained in the session of 1854-5, and the works were finished in 1859. The loch, lying 367 feet above the sea, forms a large reservoir for the catchment basin above it, in which the rainfall is very large. To fit the lake for supply purposes, its level was raised 4 feet, and arrangements were made so that it could be drawn down 7 feet in all, giving an available storage of 5600 millions of gallons. The water is conveyed to the town by a conduit twenty-six miles in length.

In 1855 he was requested by the British Association to prepare a general report on water supply, and, in pursuance of the request, he presented, at the meeting at Glasgow, in September of that year, a communication "On the present state of our knowledge on the Supply of Water to Towns. By John Frederic Bateman, F.G.S." It was a paper of some length and considerable merit. After stating the general nature of the problem, and giving a historical outline of previous measures, it enumerated the various sources from which towns could be supplied, and discussed their comparative merits, adding examples and statistical data in illustration.

In 1861, when the British Association held their meeting at Manchester, under the Presidency of Mr. Fairbairn, his son-in-law undertook the post of President of the Mechanical Section.

Mr. Bateman was elected a Fellow of the Royal Society on June 7, 1860. He served on the Council in the years 1865 and 1866.

At the end of 1869, the Viceroy of Egypt invited the Royal Society to send a representative to be present at the opening of the Suez Canal, and on the recommendation of the President, General Sir Edward Sabine, Mr. Bateman was selected for the duty. On his return he wrote to the President a long report of his visit, which was read to the Society on the 6th January, 1870, and was published in full in the 'Proceedings.' Mr. Bateman gave an interesting historical notice of the negotiations and proceedings which had been going on for many years on the subject, and had terminated in the successful completion of the enterprise. He added a general description of the Canal and of the ceremony of its opening, and he concluded with the following eulogium:—

"The Canal must be regarded as a great work, more from its relation to the national and commercial interests of the world than from its engineering features. In this light it is impossible to over-estimate its importance. It will effect a total revolution in the mode

of conducting the great traffic between the East and the West, the beneficial effects of which, I believe, it is difficult to realise. It is in this sense that the undertaking must be regarded as a great one, and its accomplishment is due mainly to the rare courage and indomitable perseverance of M. Ferdinand de Lesseps, who well deserves the respect he has created and the praises which have been bestowed. . . . A channel of water communication has been opened between the East and the West which will never again be closed so long as mercantile property lasts or civilisation exists."

The waterworks which Mr. Bateman had constructed for Manchester and for Glasgow, although both of gigantic magnitude, did not satisfy his ambition. He saw the treasures of water which were annually wasted by floods in mountain districts, and he longed to originate some great schemes for utilising them. He said:—

"I could never see the wisdom of the view which would confine the supply of water to the towns and places which lay within any particular watershed. Where the water was most abundant it was generally the least wanted; and towns had grown up where it was often difficult to obtain this essential contribution to life and prosperity. To my mind, the idea of confining such places to their own watersheds, and preventing their going for what they wanted where there was enough and to spare, was absurd. As well might it be urged that the coal produced in the neighbourhood of Newcastle should all be consumed in the Valley of the Tyne, and none of it conveyed to London or the Valley of the Thames."

About 1869 an opportunity offered for exemplifying this principle. There had been a good deal of discussion as to the water supply of London, and Mr. Bateman designed a project for supplying the metropolis from a mountainous district in North Wales, where the rainfall was very large. He proposed to collect the water in artificial reservoirs, and to bring it to London by conduits above 180 miles long, delivering it at such a level as would give the supply entirely by gravitation. The plan was submitted to a Royal Commission, of which the Duke of Richmond was Chairman, and who reported in 1868. They expressed a high opinion of the plan, but decided that, for the present, at least, the metropolis did not require so expensive a measure.

Some years later, however, Mr. Bateman's ambition was gratified in another way. When, in 1877, he reported to the Corporation of Manchester that the waterworks were finished, he did not conceal from them that he had for some time been anxious about the future, inasmuch as the enormous growth of the town was fast outrunning the capacity, great as it was, of the Longdendale source of supply. He reverted to his former principle of resorting to mountain districts,

where large quantities of water were running to waste, and he found this eminently the case in the Lake District of Cumberland. The Corporation took up the idea, and in 1879 an Act was passed for obtaining a large supply from Thirlmere by a conduit 100 miles long. In this Mr. Bateman was associated with Mr. George Hill, of Manchester, by whom the works are now being carried out.

Mr. Bateman's knowledge of water supply involved several points of original scientific investigation. The chief one was on the subject of rainfall and its accompanying phenomena. When he undertook the work of the Bann Reservoirs, in 1835, he was surprised to find how little trustworthy information was available as to the two points of greatest importance, namely: (1) the rainfall upon the surface, and (2) the proportion of this that flowed off in the streams and rivers. With laudable zeal and industry he determined to remedy this difficulty for the future by establishing on the ground a regular system of observations on both points. After this time, in the course of his Manchester practice, he was engaged, more or less directly, on several other proposals or undertakings which had to do with water supply in the neighbourhood; and in every one of these he followed up his enquiry either by obtaining the best records available, or making new sets of observations entirely his own.

The knowledge gained in these enquiries emboldened him to read two papers before the Literary and Philosophical Society of Manchester, viz.:—

“Observations on the Relation which the fall of Rain bears to the Water flowing from the Ground” (read 6th February, 1844); and

“Report of the Committee for superintending the placing of Rain Gauges along the lines of the Rochdale, Ashton-under-Lyne, and Peak Forest Canals. With observations, &c.” (read 18th March, 1845).

These early papers contained valuable facts, and showed considerable power of scientific reasoning upon them. But the subject was a favourite one with Mr. Bateman during his whole career. He seldom wrote a report on water undertakings without giving explanations thereon, and, as late as 1883, he wrote a special paper for the Victoria Institute, entitled “Meteorology and Rainfall.”

He was a great advocate for the use of soft water; and one of his later works, in the Colne Valley near Watford, was remarkable for his successful application of the elegant chemical principle of the late Dr. Clark, for softening hard chalk water by lime; a great boon to the populations supplied.

In 1878, Mr. Bateman was elected President of the Institution of Civil Engineers, an office which he filled two years. In his opening address, delivered 15th January, 1878, in addition to the usual professional topics, he enlarged on the subject of engineering education, pointing out particularly the necessity for the cultivation of

science in those branches that bear on the operations of the profession.

It has only been possible here to mention a few of the works by which Mr. Bateman has been most widely known, but his practice was very large, and he occupied a high position in his profession.

Mr. Bateman died at his residence, Moor Park, Farnham, on the 10th of June, 1889.

W. P.